



# The global climate challenge

Talk to Friends of Earth  
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# The global climate challenge

The challenge to accept the science

The challenge to accept the consequences

The challenge to involve everybody

The challenge for a fair and equitable global solution

Do we understand the Earth's climate system?

Where are we now?

Where are we going?

How bad can things get?

What do we need to do?

Can I make a difference?





MARS

EARTH

VENUS

MERCURY

227 million km

150 million km

108 million km

58 million km

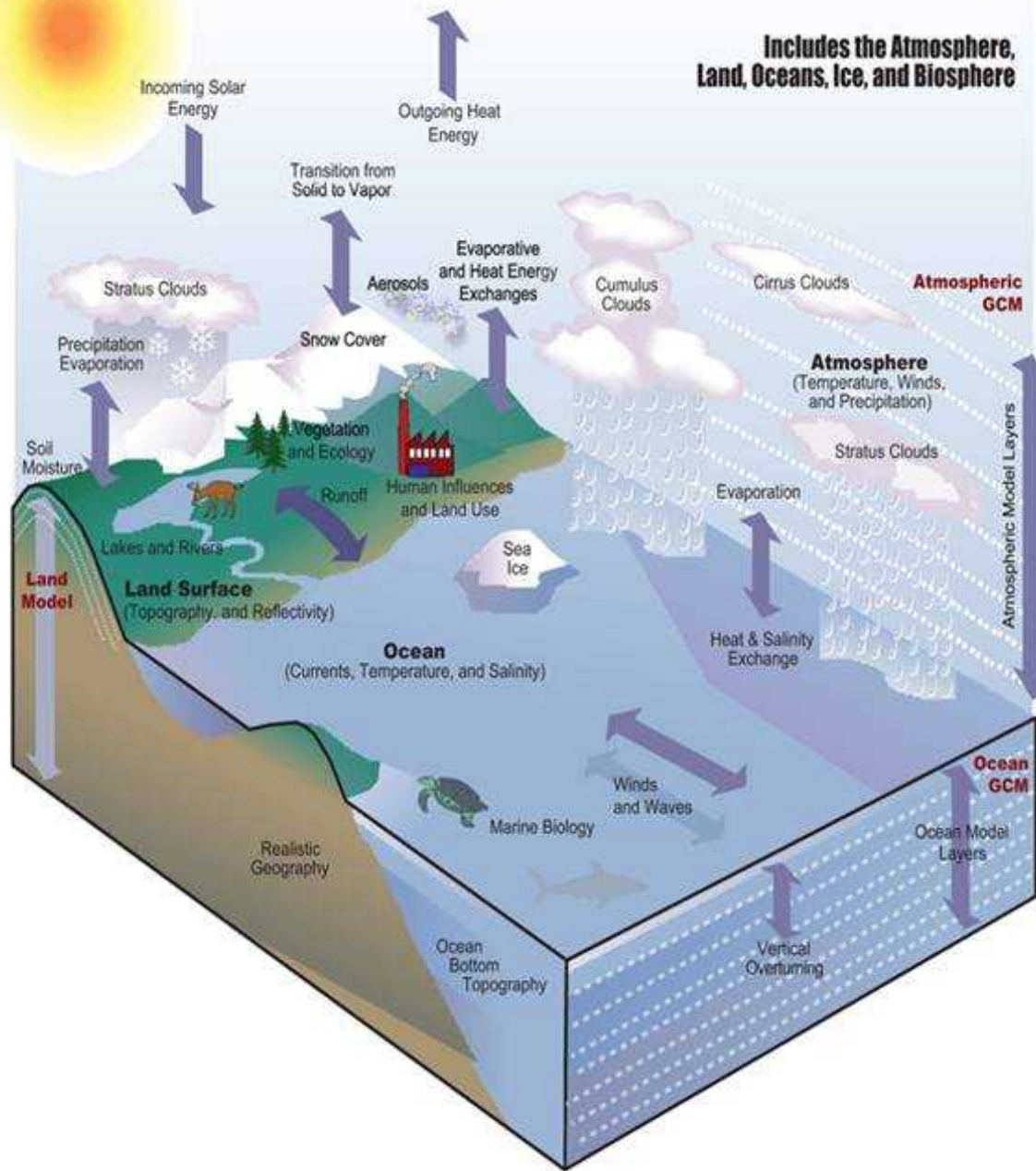
-47°C

15°C

477°C

Max 450°C min -180°C

# Modeling the Climate System



Includes the Atmosphere,  
Land, Oceans, Ice, and Biosphere

## The weather machine

- A dynamic system of air and ocean currents driven by the Sun
- Complex with clouds, ice, snow, rain and sea ice and particles

# Drivers of climate change

The Sun

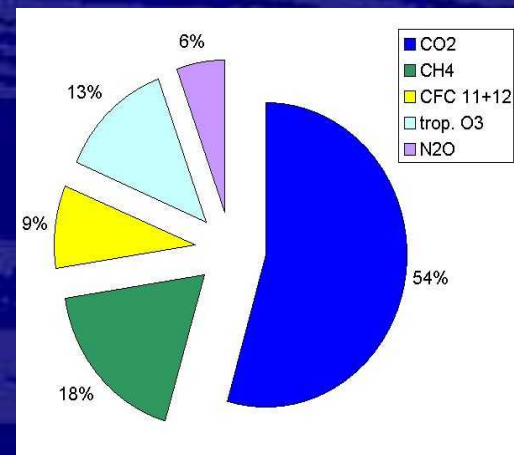
- Three major factors influence climate change
  - Solar influx
  - Albedo
  - Atmospheric composition

- Only one has changed significantly over last 300 years

- Carbon dioxide up 36%
- Methane up 150%
- Nitrous oxide up 17%
- Tropospheric ozone up 35%

The land surface

Gases in the atmosphere



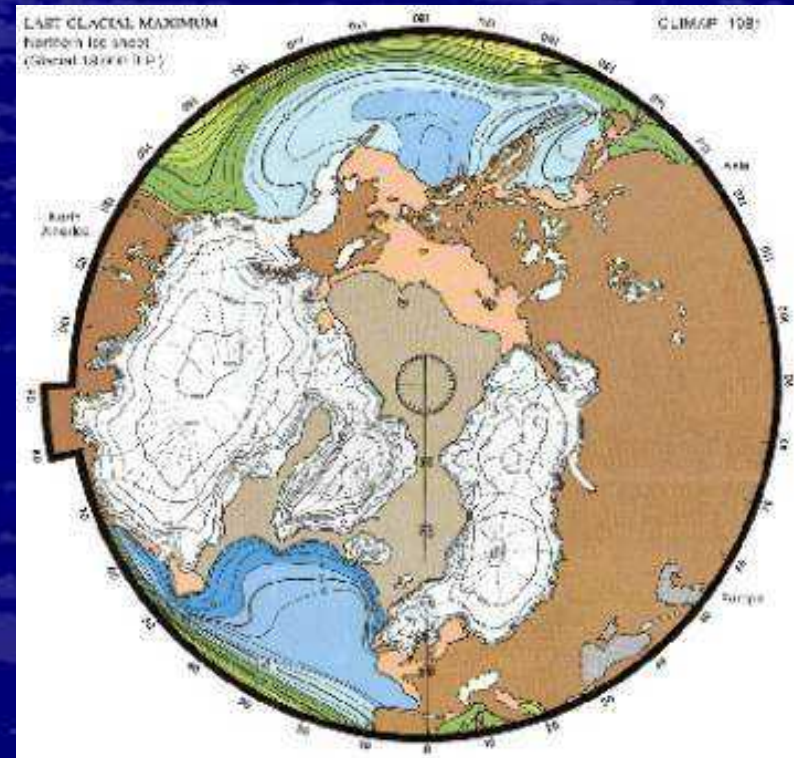
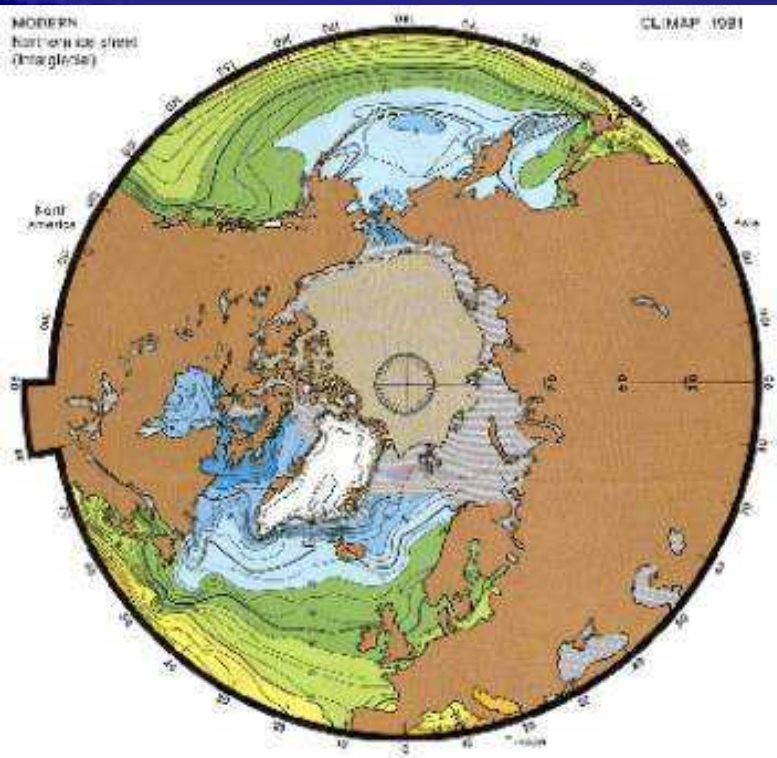
# Last Ice Age

Albedo changed  
Greenhouse gases changed  
AND we know how the climate changed

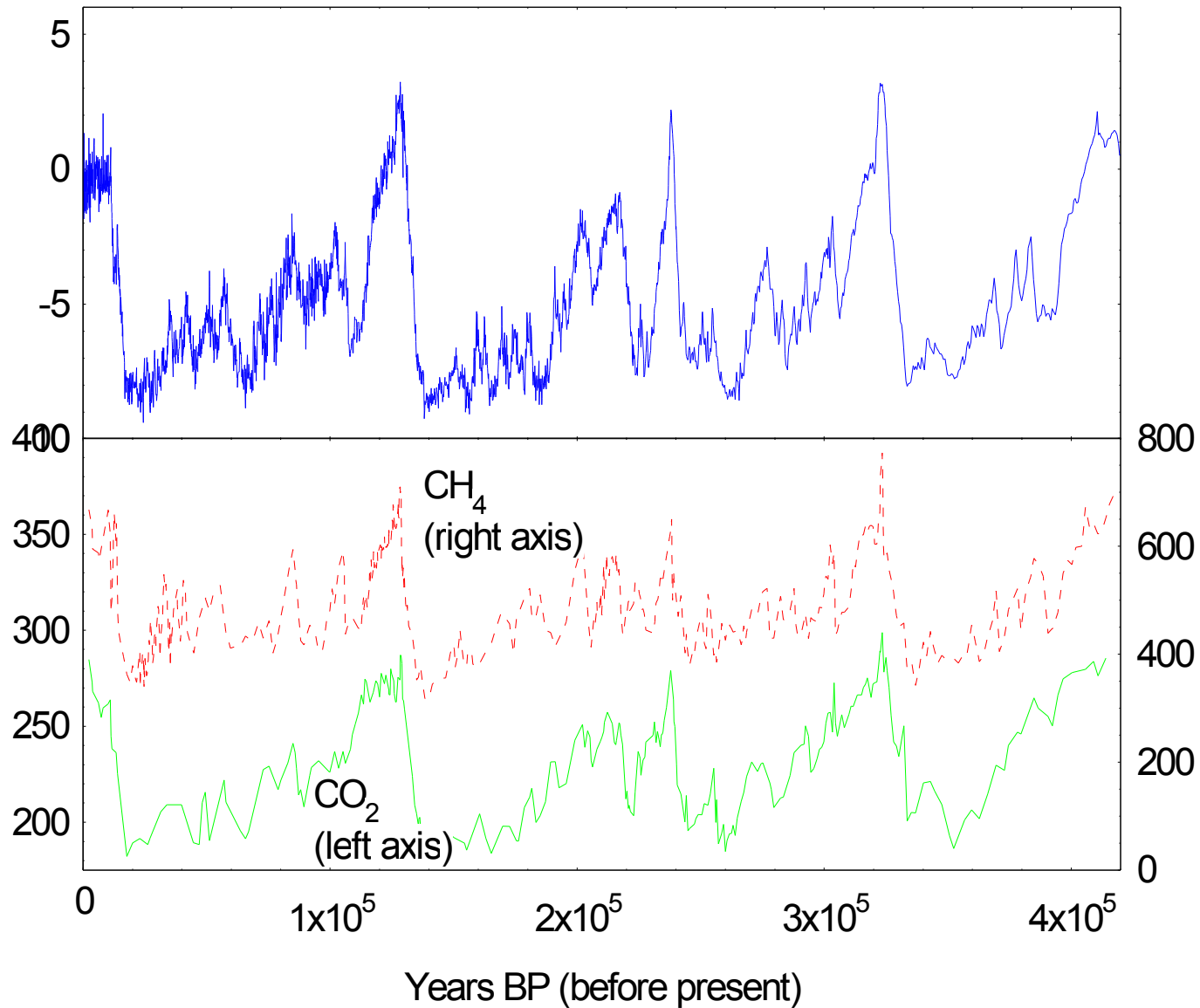
Enough information check out how sensitive the Earth is to changes in Greenhouse gases

*Today*

*Last Glacial Maximum*



# Four glacial cycles in the the Vostok ice core over 400,000 years



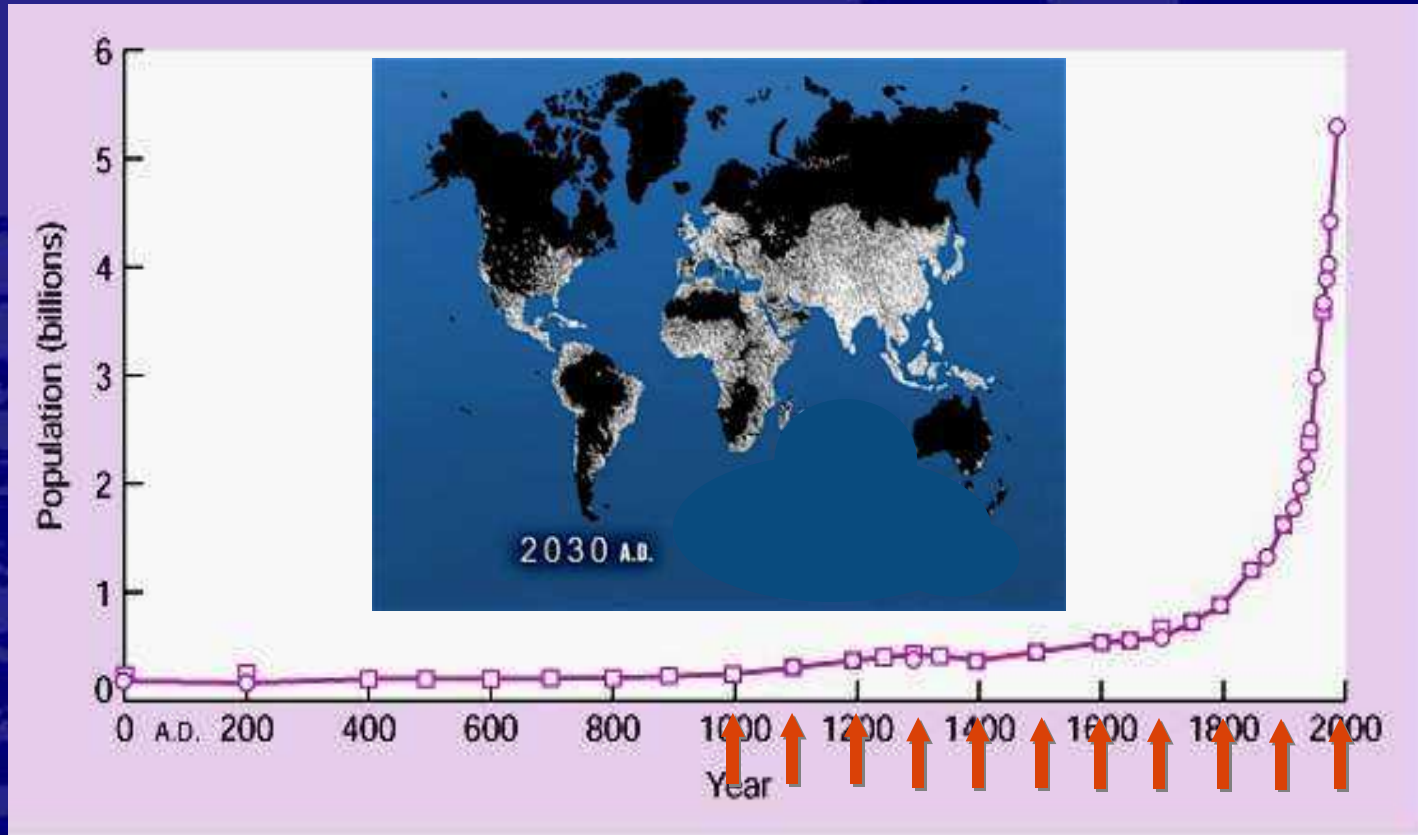
## From studies on ice cores



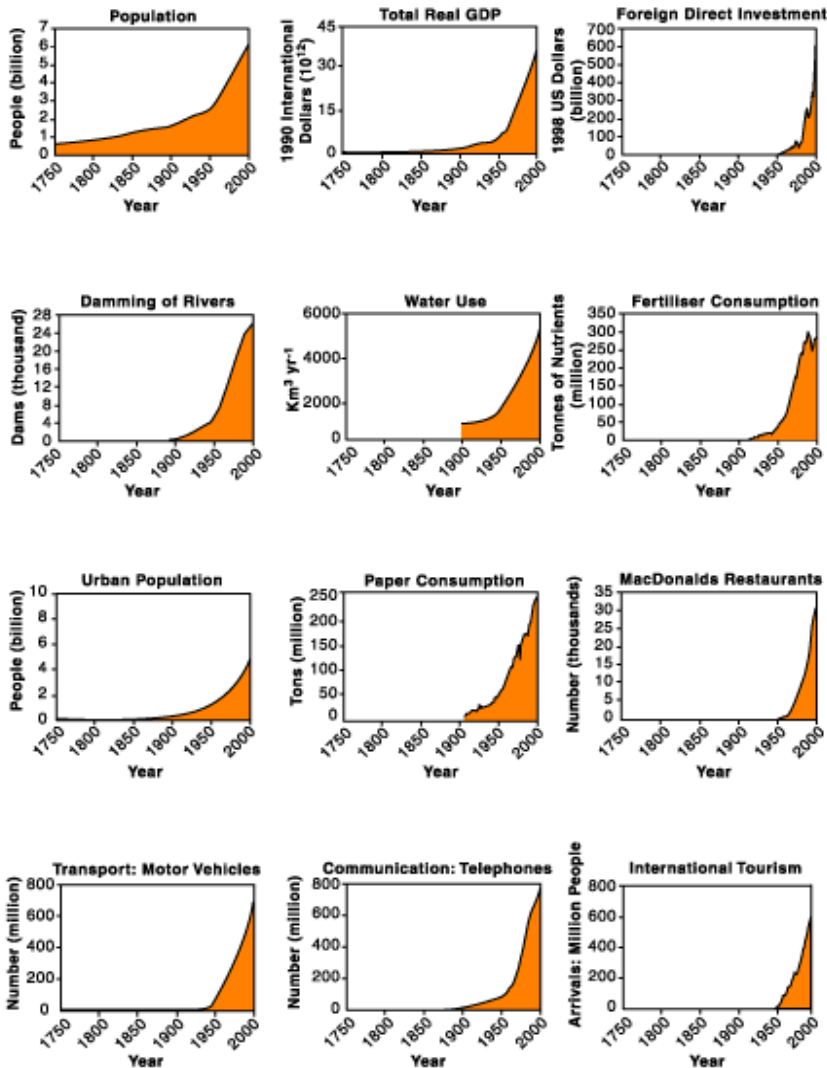
- Know the natural limits of atmospheric greenhouse gases during the last 1 million years
- Understand the positive feedbacks that made ice ages so much colder than interglacials
- Have confirmation of the power of greenhouse gases in creating the climate of ice ages and interglacials
- Find no occasion in which temperatures fell as atmospheric greenhouse concentrations rose



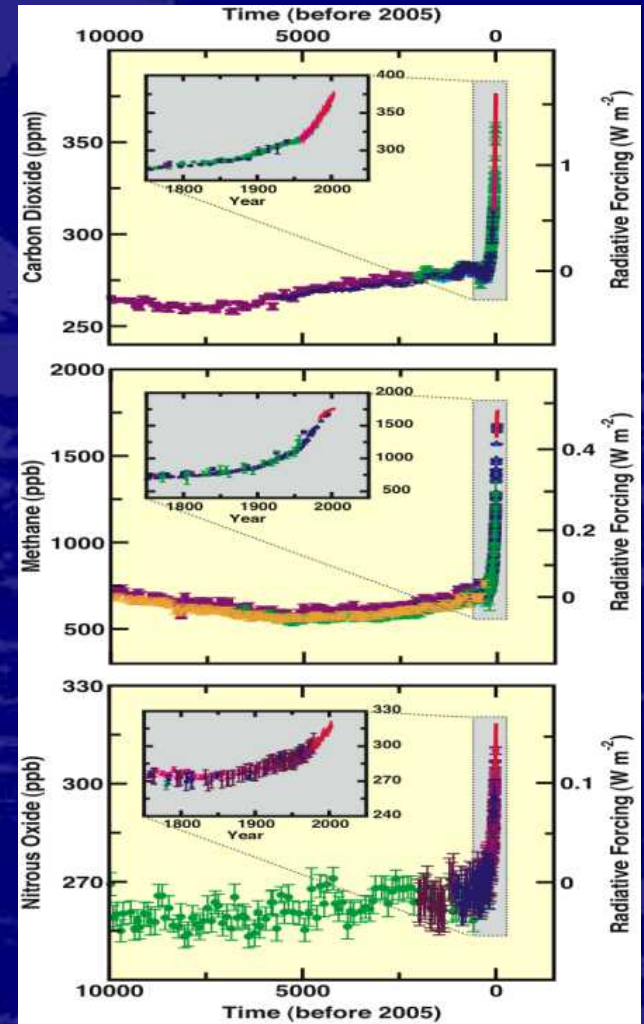
# Human Population Growth \*



# Ever upwards



Lifestyles in an exponential world  
1750-2000



Greenhouse gases  
10,000 BC-2000 AD

# In Uncharted Territory



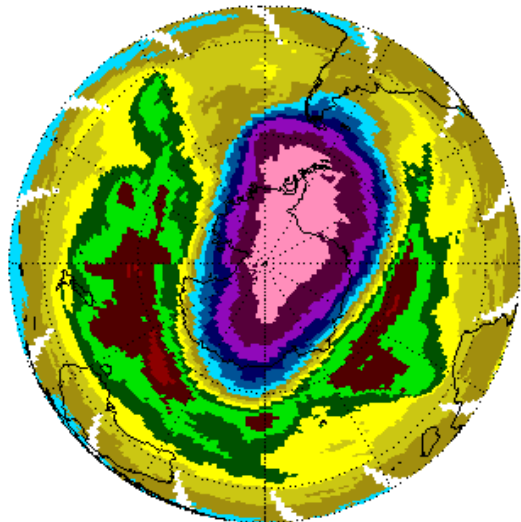
by far the most terrifying film  
you will ever see.

- The human race has substantially altered the Earth's atmosphere. In 2007 the concentration of carbon dioxide far exceeded the natural range that has existed over 650,000 years

# The Antarctic ozone hole 1985

## First appreciation of the fragility of Planet Earth

EP/TOMS Total Ozone for Oct 21, 1998



Dobson Units  
Dark Gray < 100, Red > 500 DU



GSFC/916

GEN:296/1998



UNITED NATIONS FRAMEWORK  
CONVENTION ON CLIMATE CHANGE  
Rio de Janeiro : June 1992  
ARTICLE 2: OBJECTIVE



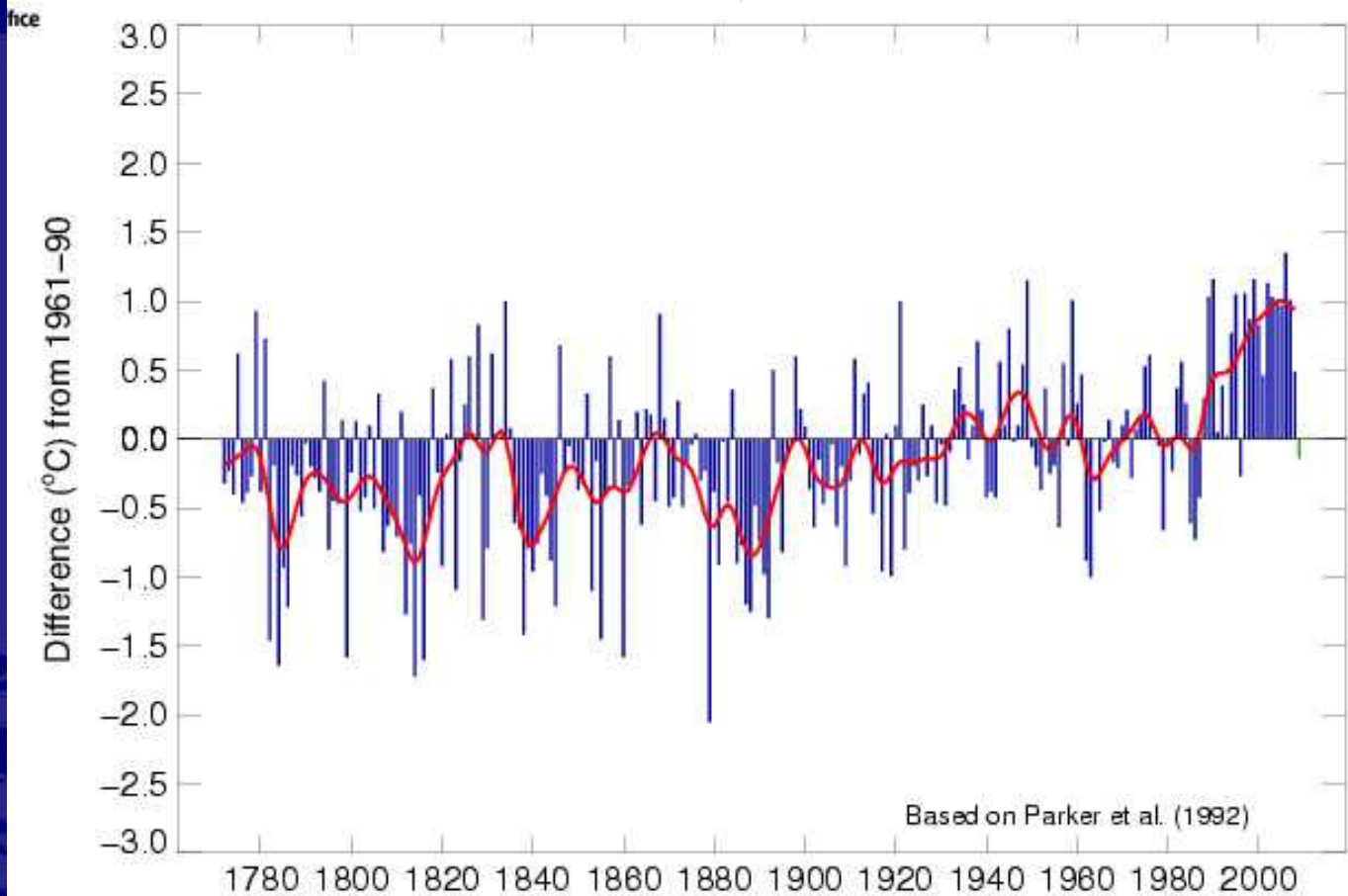
The ultimate objective of this Convention is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

Such a level should be achieved within a time-frame sufficient :

- to allow ecosystems to adapt naturally to climate change
- to ensure that food production is not threatened, and
- to enable economic development to proceed in a sustainable manner

# It is getting warmer

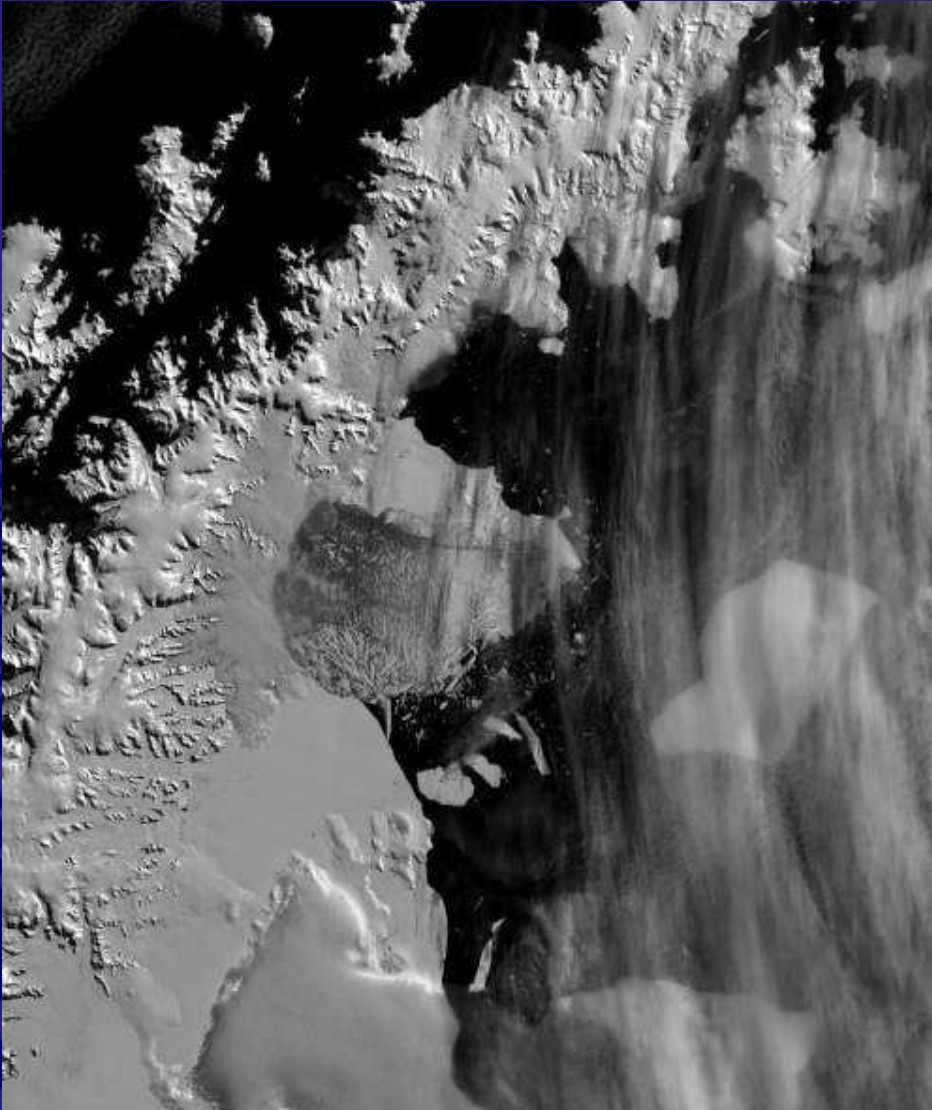
In 20th Century average global temperature rose 0.74 degrees C



Central England Temperature 1772 to 7 March 2009

- Eleven of the warmest years since the start of instrumental records occurred during the last 12 years.

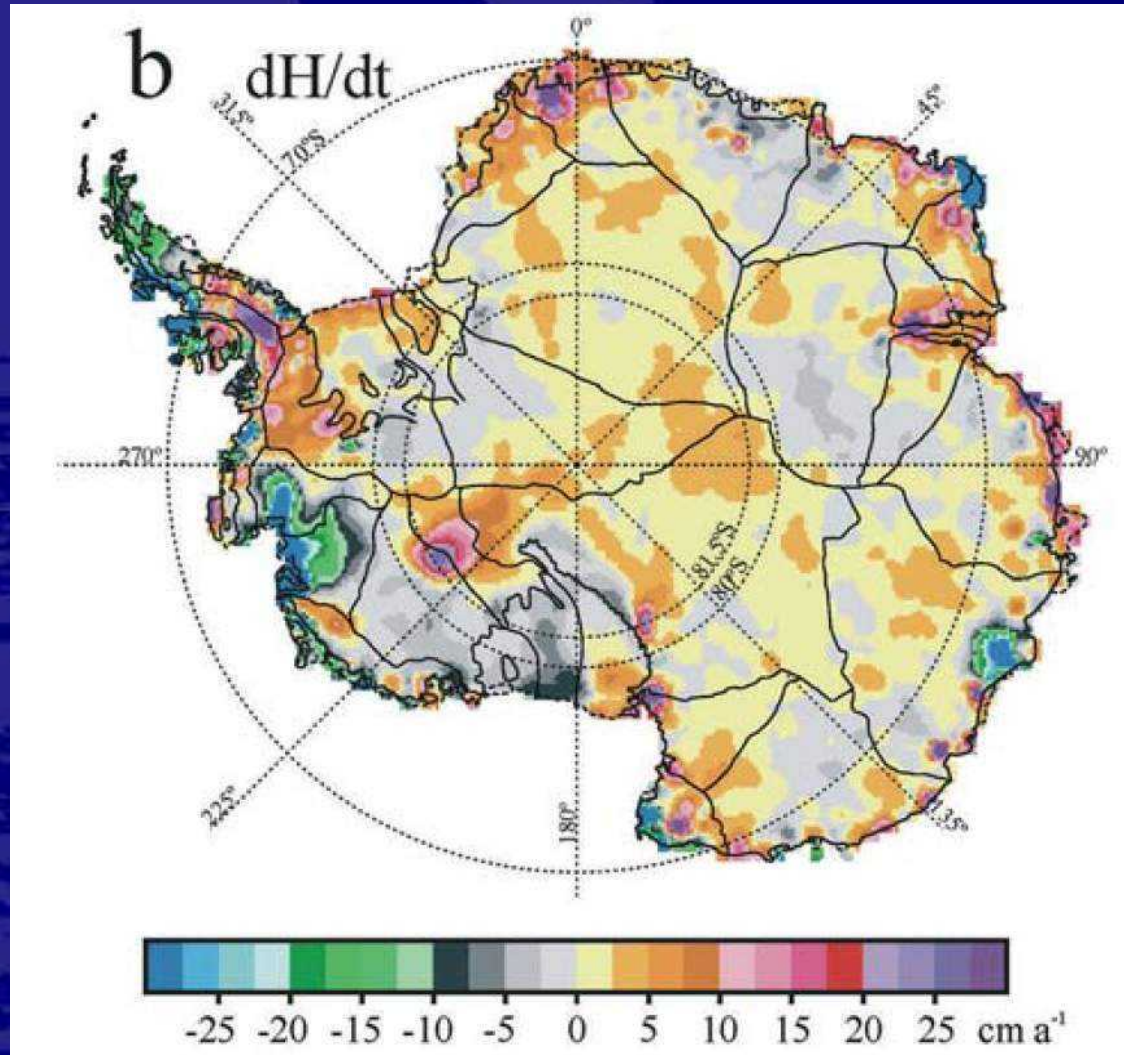
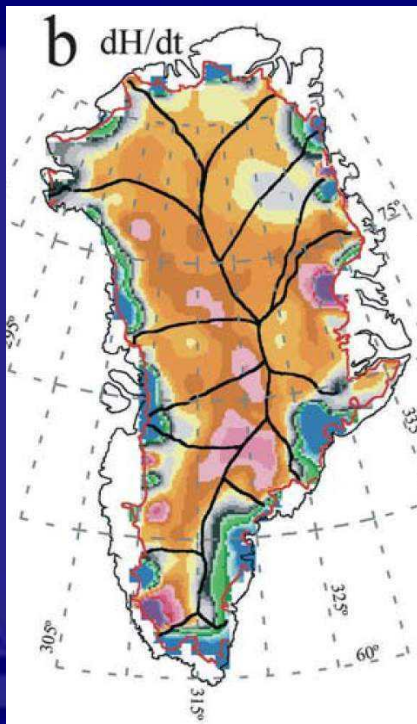
# Snow and ice disappear



Disintegration of an Antarctic ice shelf

- Widespread glacier retreat affects availability of water to millions in Asia
- Winter snow cover declines 10% since late 1960s and permafrost thaws
- Greenland's ice sheet experiences more extensive summer melting
- Arctic sea ice thins and becomes less extensive
- Antarctic ice shelves disintegrate and coastlines retreat

# Ice sheet elevation changes Greenland and Antarctica



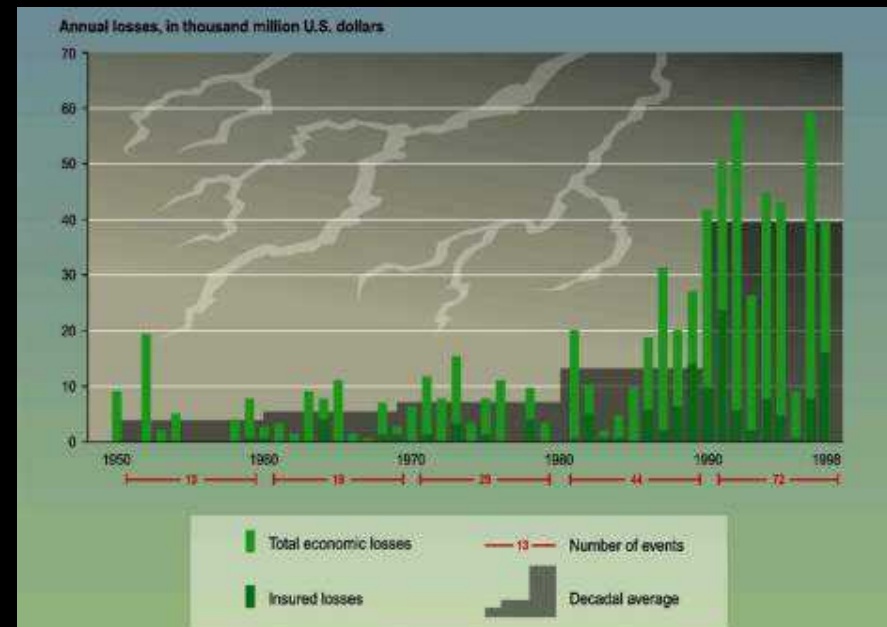
Sea level rise



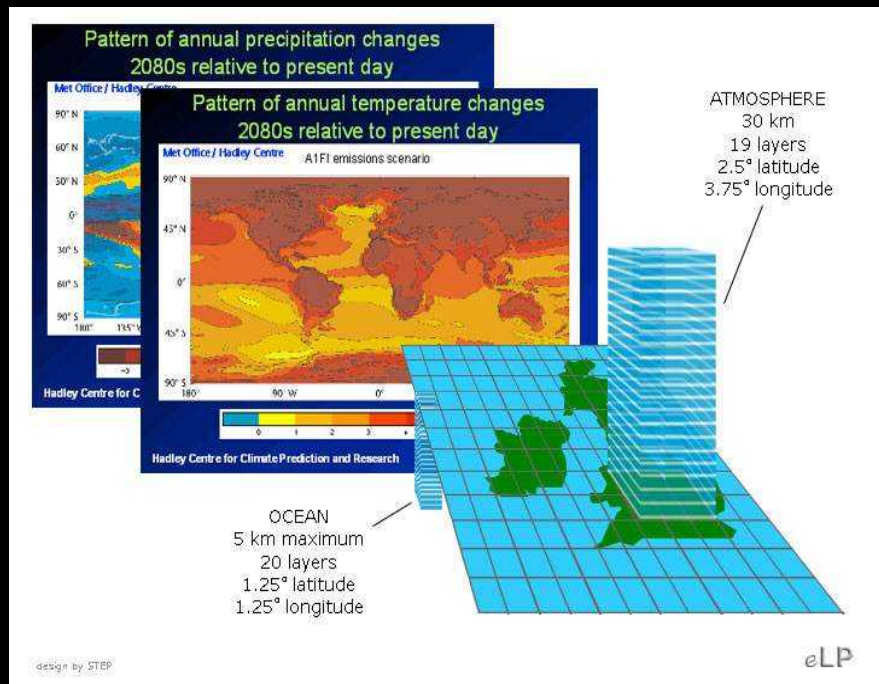
# Extreme weather is more prevalent

- Many parts of the world have recently suffered major heat-waves, floods, droughts and extreme weather events leading to significant loss of life and economic costs. 2005 (year of Hurricane Katrina) and 2008 were the costliest years ever for the insurance industry.
- While individual extreme weather events cannot be directly linked to human-induced climate change, the frequency and magnitude of these events are expected to increase in a warmer world

IPCC Chairman, Bob Watson



# Climate models on supercomputers



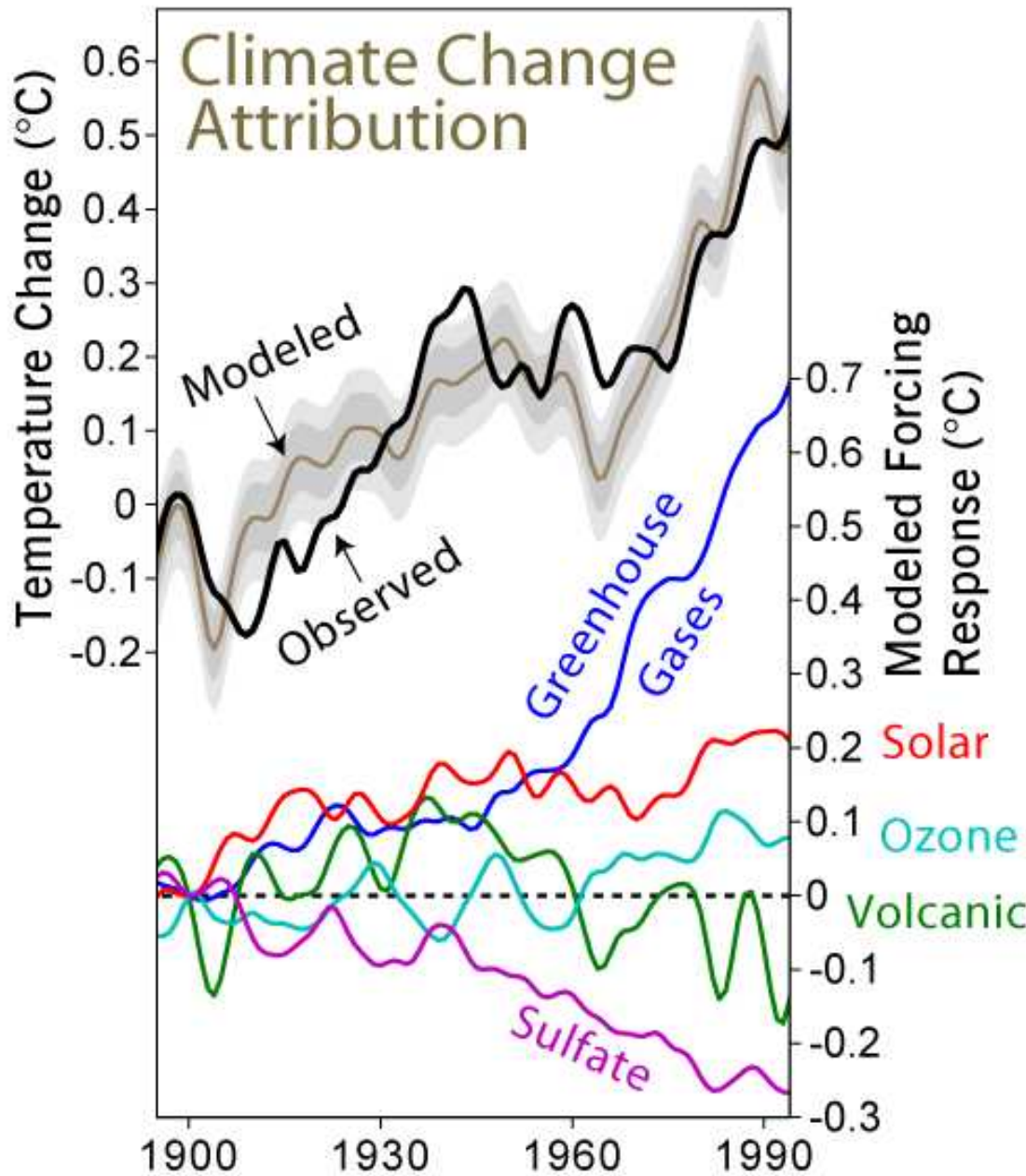
- Provide credible simulations of climate at sub-continental scales and over seasonal to decadal scales
- Incorporating results from a range of models provide useful projections of future climates and for “hindcasting” past climate

## Uncertainties in the models

- Clouds and the size of raindrops, dependent on the presence of aerosols

## “Could do better” in the models

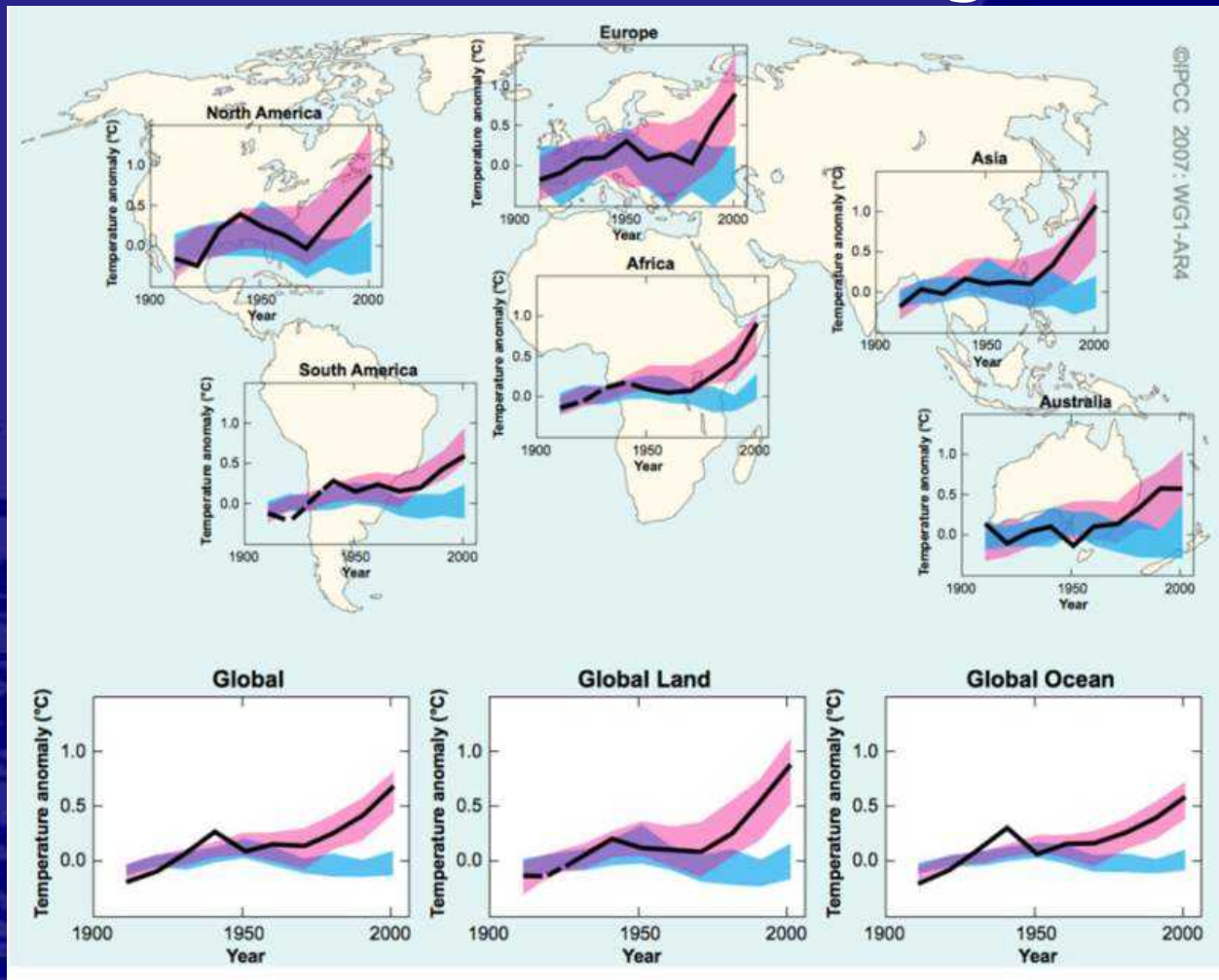
- The strength of ocean currents and the formation of deep water
- The extent and movement of sea ice



# Attribution

- 100 years of temperature as observed and as modelled in GCMs
- If we understood the past, we would have confidence in predicting future
- Variable solar and volcanic influence
- Influence of Greenhouse gases and aerosols are progressive

# Global and continental change - IPCC 2007



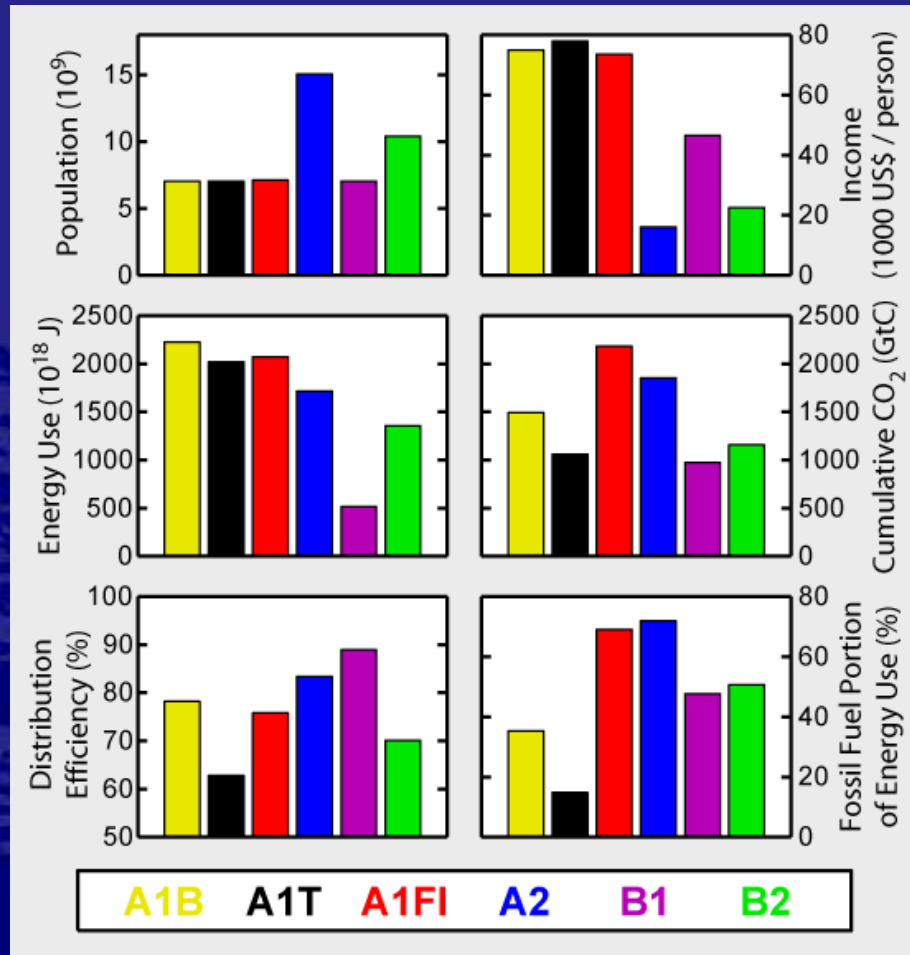
Highly successful creation of the past climate in computer models. We have confidence for future predictions using the same programs.

# What will the future climate be like?

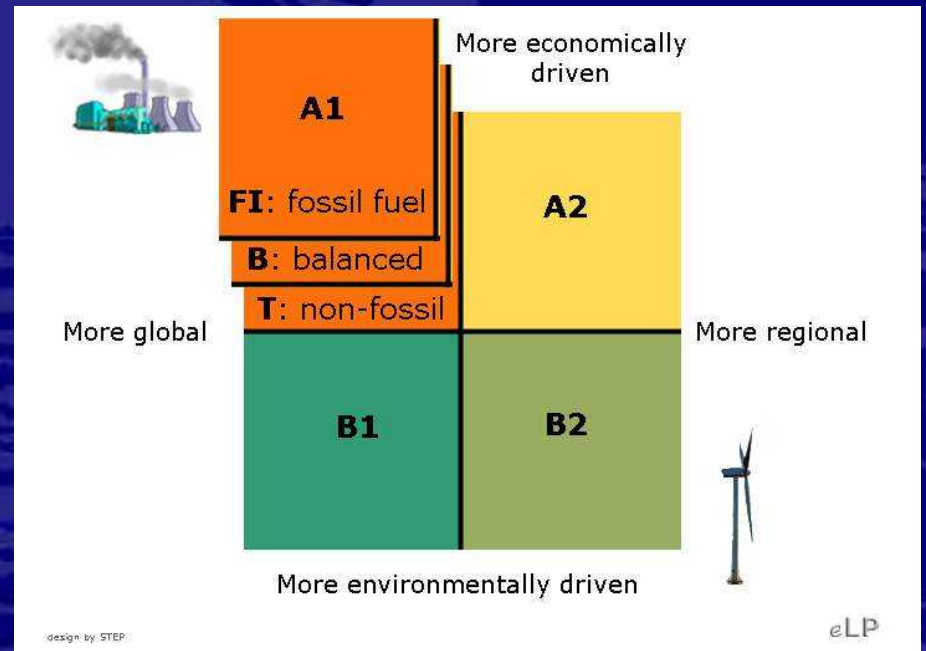


- The future climate will depend on our chosen lifestyles
- It will depend on how much oil, gas and coal we use
  - and we can't predict that
- Scientists have made climate predictions that allow for a wide range of possible future energy use

# IPCC Scenarios for future lifestyles

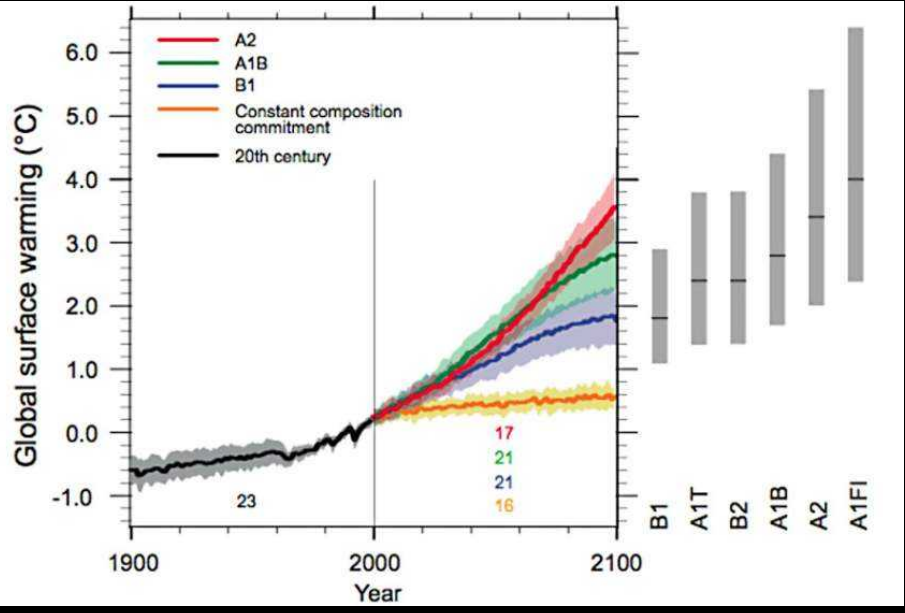


Each scenario represents a vision of the world that might occur if global warming were not a factor



The world in 2100

A1 scenarios have rapid economic growth. B1 and B2 have increased concern for sustainable development and environment



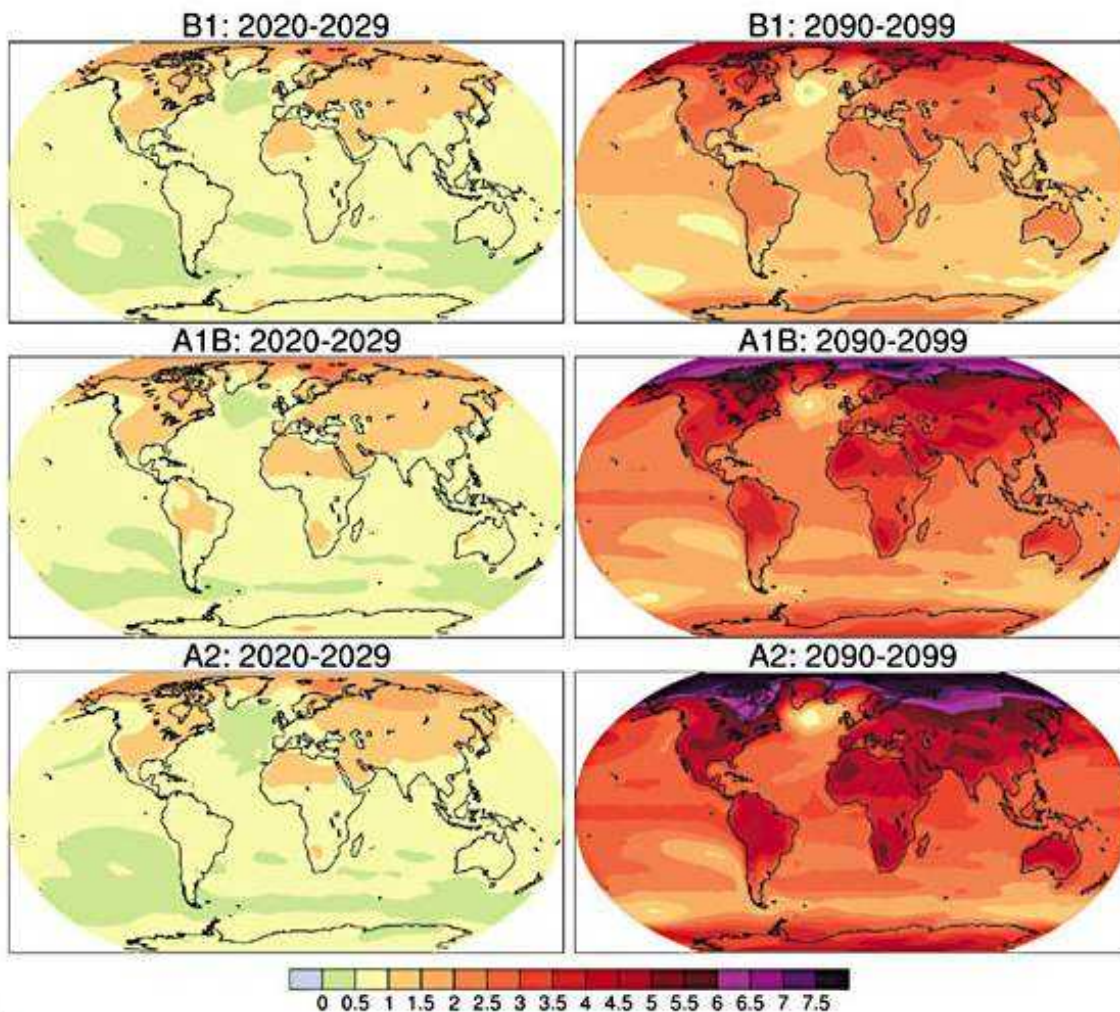
# IPCC 2007 and Copenhagen 2009 Bullet Points

- By 2100
  - The “greenest” scenario: best estimate 1.8°C, at least 1.1°C
  - “Business as usual” : best estimate 4.0°C, maybe 6.4°C
  - Arctic summer sea ice is likely to have disappeared
  - Sea level rise of over 1 m
- During this century and beyond
  - Very likely increase in the number of heat waves
  - Likely increase in the intensity of tropical storms
  - Climate change continues for centuries even if we stabilize the concentration of gases, so adaptation is inevitable

# Projected patterns of temperature change

2025 and 2095 compared to 1990

Three scenarios of lifestyle development  
IPCC 2007



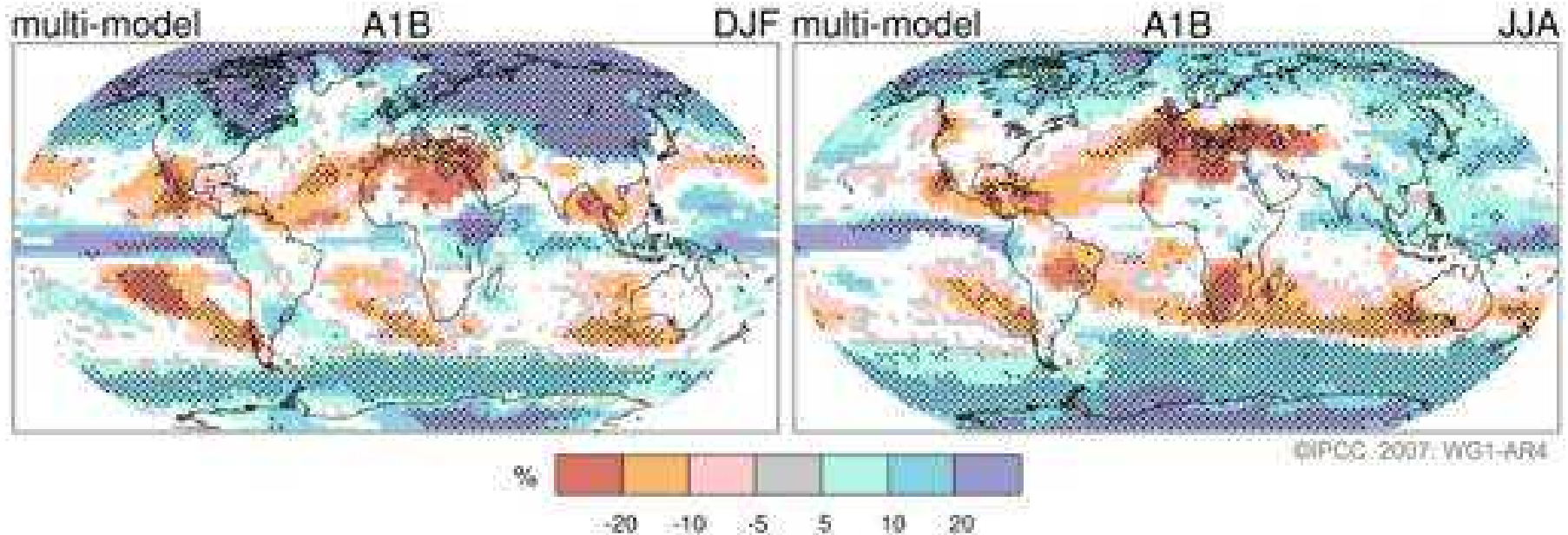
IPCC 2007 WGI-ARR4

- Future actions influence climate in 2095 but not 2025
- 2025 climate a result of past actions
- Land warms faster than sea
- Polar regions warm faster than tropics



# Projected patterns of precipitation change 2095 compared to 1990

A1B scenario IPCC 2007



- Left: Winter Right: Summer
- White areas: Less than 66% agree direction of change
- Stipple areas: Over 90% agree direction of change
- Water cycle intensifies: Droughts & storms worsen
- Less precipitation over North Africa/Mediterranean
- More precipitation over temperate latitudes and poles

# Developing countries suffer the most



- **Desertification**

- By 2025 the number of people affected by desertification is expected to double to 1.8 billion; many will be in Africa.
- By 2020 75 to 250 million people in Africa may be water stressed.
- By 2080 Africa and South America may lose some large rain forests

- **Rainfall and flooding**

- Flooding, soil erosion, landslides, avalanches and mudslides likely to increase
- Many crops on which human race depends decline in yield and productivity
- The incidence of vector-borne diseases, such as malaria, increase
- Sea level rise affect tens of millions of people, particularly in Asian deltas

# Biodiversity



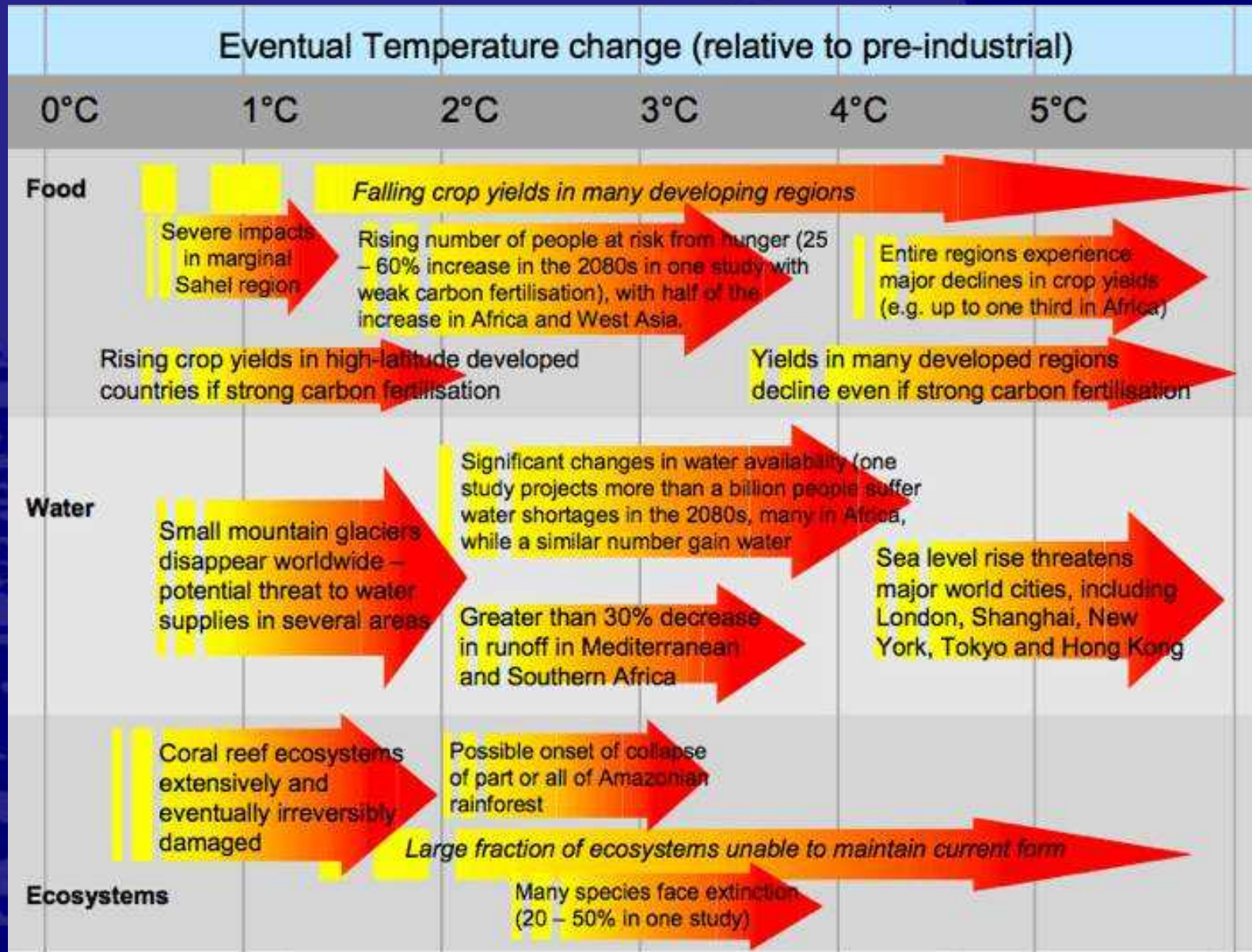
- Many species of plant and wildlife are expected to become extinct.
- The structure and functioning of critical ecological systems, particularly coral reefs and forests, will change, affecting their goods and services that are vital for sustainable development.
- Human environmental migration is predicted as many people move from high flood risk or arid regions
- UN puts the number of refugees at 150,000,000 refugees - 2% of global population on the move by 2050

# Sleeping Giants



- Once set in motion these will carry on whether we slash emissions or not
  - West Antarctic Ice Sheet on the slide
  - Greenland's ice cap melts
  - Ocean conveyor belt shuts down
  - Methane burps
  - Soils give up their carbon stores
  - Oceans become more acid
  - Regional impacts
    - Death of the Amazon
    - The greening of the Sahara
    - Monsoon disrupted
- The threshold temperature at which each of these sets in will be different but each makes climate change more dangerous
- Decision time: what do we aim for?

# Global temperature thresholds





A ceiling on atmospheric  
greenhouse gas concentrations?  
A ceiling on global temperatures?  
Each depends on the other

Rio Earth Summit: The ultimate objective of the Climate Change Convention is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous human interference with the climate system

## What level is dangerous?

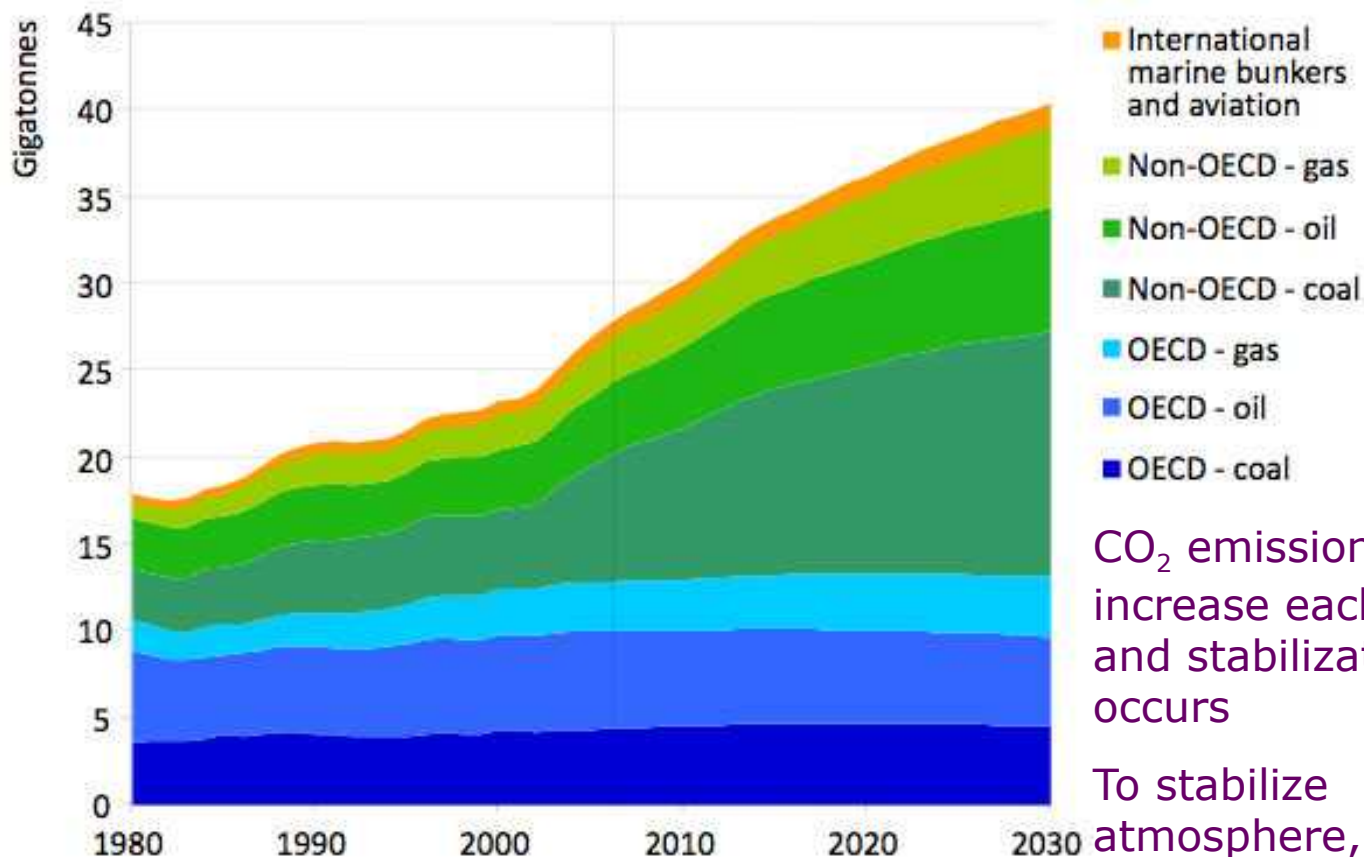
2001: IPCC focuses on 550 ppm (twice pre-industrial)

2006: EU objective to curb global temperature rise by 2°C has 50:50 chance if stabilize at an equivalent CO<sub>2</sub> level of 450 ppm that may be reached in seven years

2008: 350 ppm to ensure the world's ice caps do not melt away!

# Energy-related CO<sub>2</sub> emissions in the Reference Scenario

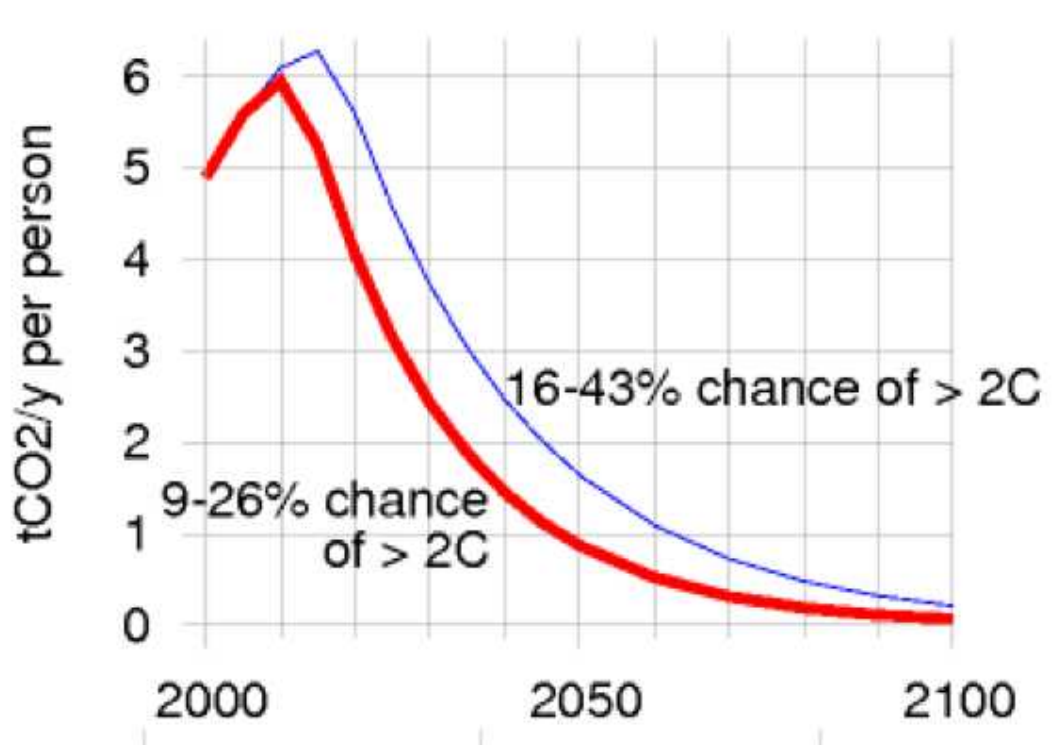
World Energy Outlook 2008



CO<sub>2</sub> emissions increase each year and stabilization never occurs

To stabilize atmosphere, emissions must fall

**97% of the projected increase in emissions between now & 2030 comes from non-OECD countries – three-quarters from China, India & the Middle East alone**



Emissions per person  
to keep climate change below 2°C

- These possibly safe scenarios require global emissions to fall by 70% or 85% by 2050
- That is a fall of emissions of between 4% and 5% each year
- Global population expected to rise at around 2% per year
- Global energy use expected to rise at around 2% a year
- UK's highly contentious Climate Change Bill sees 80% cuts in emissions by 2050



# The technological and human challenge for 2050



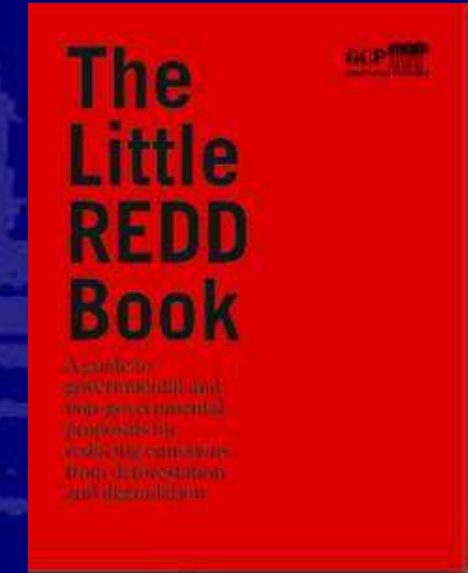
- Global emissions need to be 70% or so below current levels
- World economy expected to be 3x to 4x larger than today
- Emissions per unit of GDP need to be a tenth of current levels
- UK and Europe propose to reduce emissions by 80%



# How to save the planet

- Reduce demand for emissions-intensive goods and services
- Use energy as efficiently as possible
- Make global energy supply more efficient
- Supply as much energy as possible for power heat and transport from low-carbon and renewable sources
- Mop up CO<sub>2</sub> from the atmosphere and store it away
- Act on non-energy emissions, such as avoiding deforestation

# Disappearing tropical forests



- Forestry activities cause 20% additional greenhouse gas emissions
- Arresting deforestation is one of the cheapest ways of slowing climate change
- Addressing the causes of deforestation has become a major issue in the climate change debate

energy saving trust

Commitments so far  
**106,509**

Home Commit now Why commit Who's committed Spread the word

# I commit

Want to do something about climate change? Want to help preserve the places that matter to you? Then join the energy saving movement and make a personal commitment to save 20% of the energy you use. Together our actions will have a real impact by helping to fight climate change.

You can also create your own "commitment widget" to add to your webpage or network site and tell all your friends about your commitment.

**Latest commitment:**  
Gloria Burke committed to help preserve sherwood forest

photographer zoreil

**Commit now**

**SAVE YOUR 20%**

Too busy to commit now? You can still join the energy saving movement by leaving your email address below.

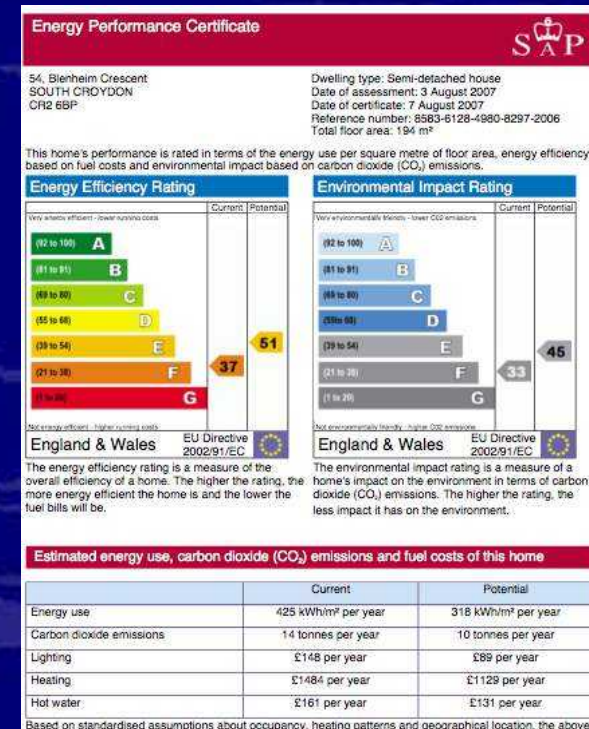
## Personal checklist

- Stop flying
- Lower temperature of your home
- Drive less and more slowly
- Don't buy clutter; avoid packaging
- Eat vegetarian six days out of seven
- Keep using old gadgets
- Change lights to fluorescent or LED
- Read your meters and and identify changes in habits
- Measure your carbon footprint



# Energy efficiency at home

- Nearly 50% of the UK's CO<sub>2</sub> emissions are caused by building, maintaining and occupying buildings
- A third of all the buildings around in 2050 have yet to be built
- Building Regulations get tougher to make significant impact on emissions and energy consumption
- Zero carbon homes are the rule after 2016
- Electrical appliances becoming rapidly more efficient
- Energy Performance Certificates



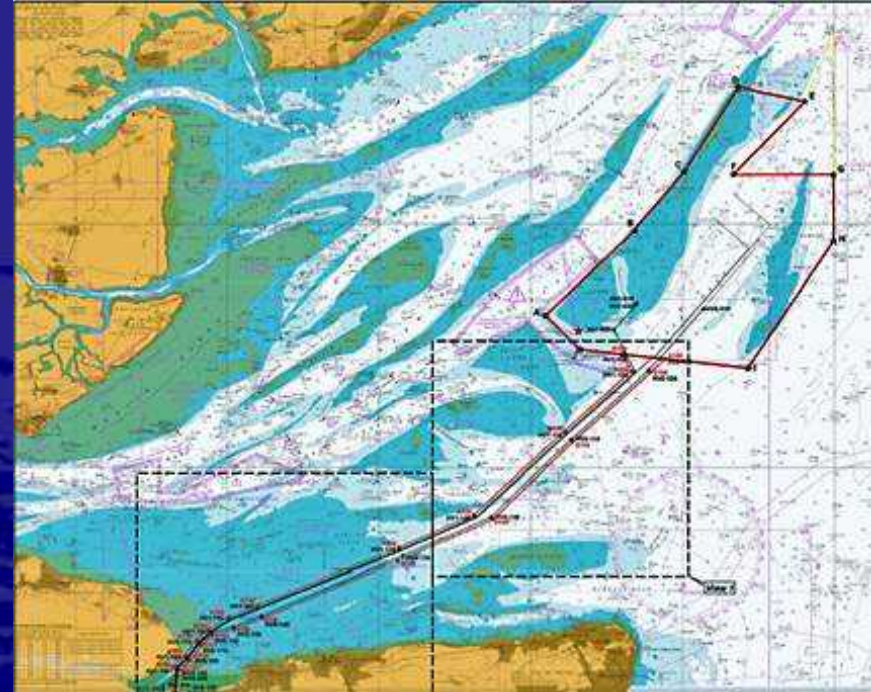
# UK Energy Policy

# 2003 White Paper

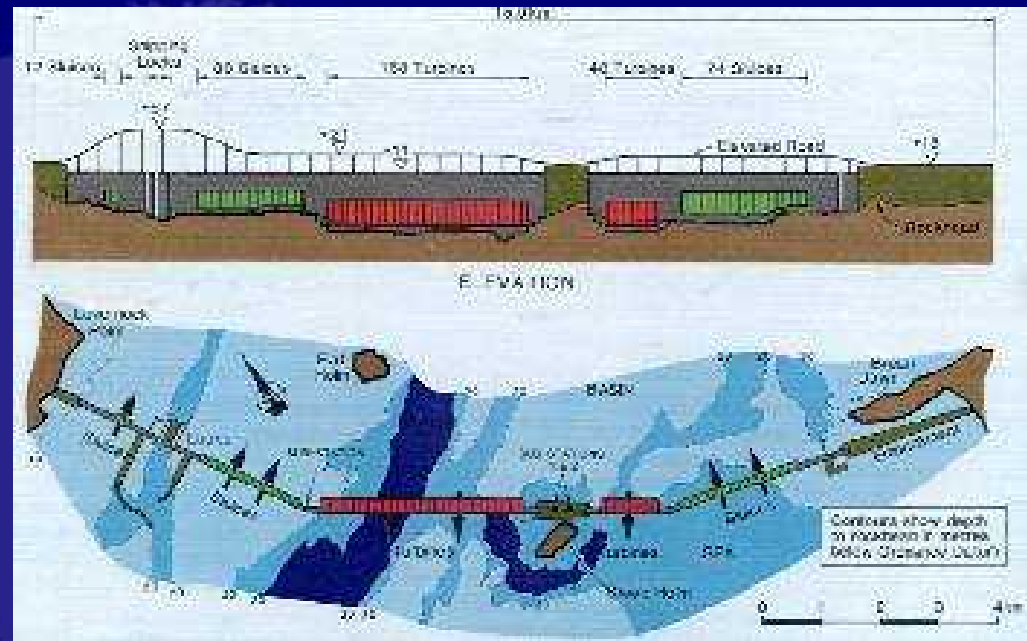


- The Vision is to see a country that creates a better environment for generations to come by generating ever increasing amounts of clean renewable energy from the abundance of natural resources available using the best innovative manufacturing facilities developed and operated within the United Kingdom

# London Array- world's largest wind farm to be?



- 1 GW power installation - cost £3 billion plus
- 270 turbines in 90 sq miles, 12 miles off Kent and Essex coast. 175 turbines operational 2012
- Provide 10% of UK target's of 10% electricity from renewables by 2010
- Generates 1% of total UK electricity
- Shell has pulled out, so may never happen



## Severn Barrage

- 16.1 km embankment
- 8.64 GW power station
- Generate 4.4% of the UK's electricity
- Cost £15 billion
- Cost of electricity (2% discount rate) 2.3p/kWh
- Cost of electricity (8% discount rate) 9.2p/kWh

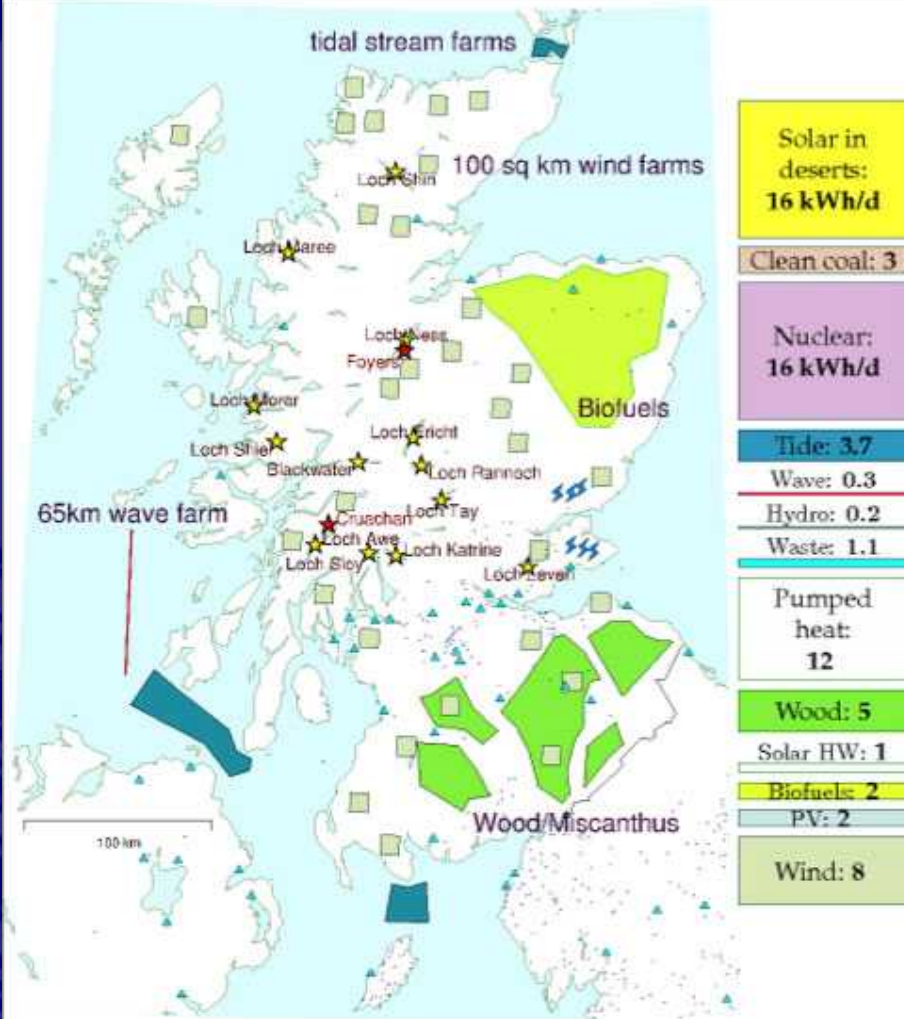




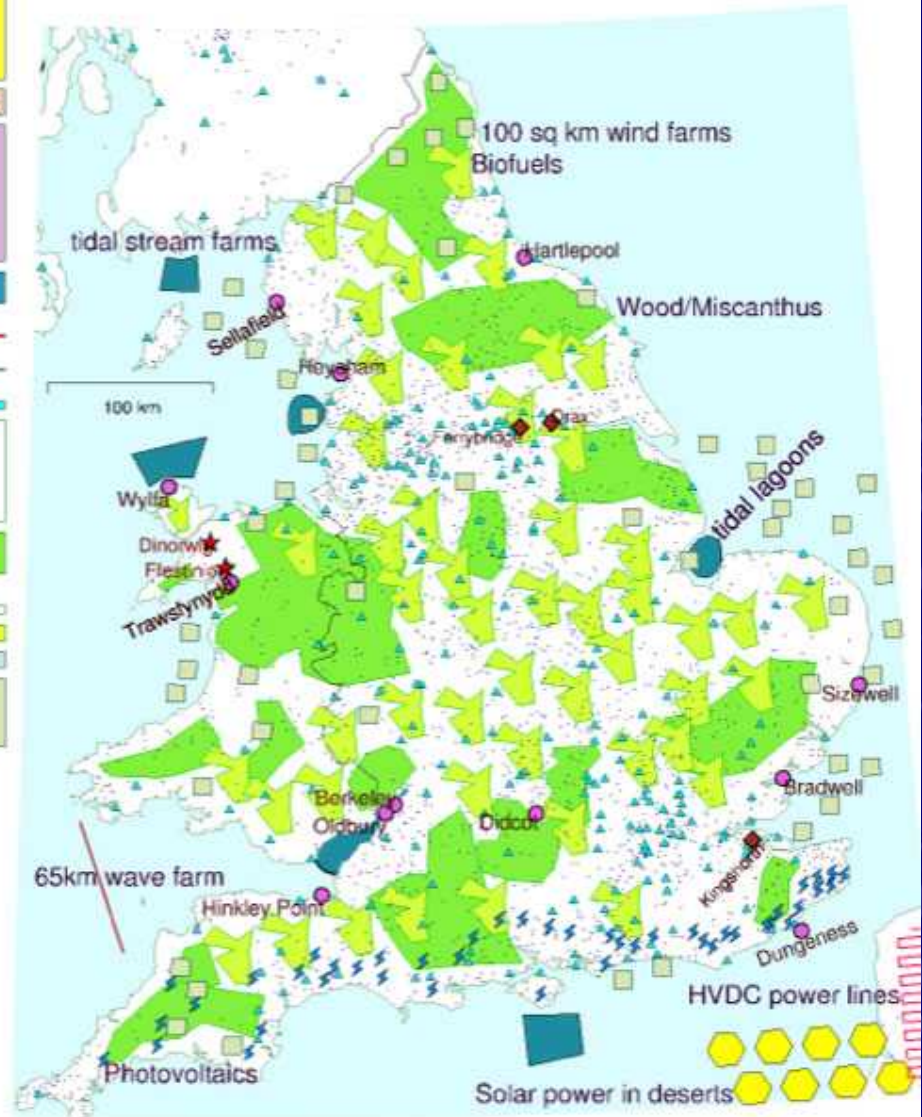
# Nuclear Power

- Nuclear energy emits no greenhouse gases during operation
- Phasing out nuclear power would make meeting carbon reduction targets more difficult
- Enhancing security against terrorist attacks to nuclear power plants and spent fuel cooling ponds increases costs
- Government has asked industry to propose the building of new nuclear stations to replace those due to retired by 2030
- European design could provide energy cheaper than wind power or tidal barrages

# UK renewables map



Solar in deserts: 16 kWh/d
Clean coal: 3
Nuclear: 16 kWh/d
Tide: 3.7
Wave: 0.3
Hydro: 0.2
Waste: 1.1
Pumped heat: 12
Wood: 5
Solar HW: 1
Biofuels: 2
PV: 2
Wind: 8



# This plan's mix Providing 60% UK energy compared to today

Solar in deserts:  
16 kWh/d

Clean coal: 3

Nuclear:  
16 kWh/d

Tide: 3.7

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12

Wood: 5

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PV: 2

Wind: 8

Four Londons' worth

Use for cofiring biomass with CCS

40GW - four-fold increase

25% of UK - forests, willow, miscanthus

1 sq m per person HW

12% of UK for biofuels

Half of all roofs

33-fold increase in wind capacity

[Jet flights: 5kWh/d/p, while oil lasts]

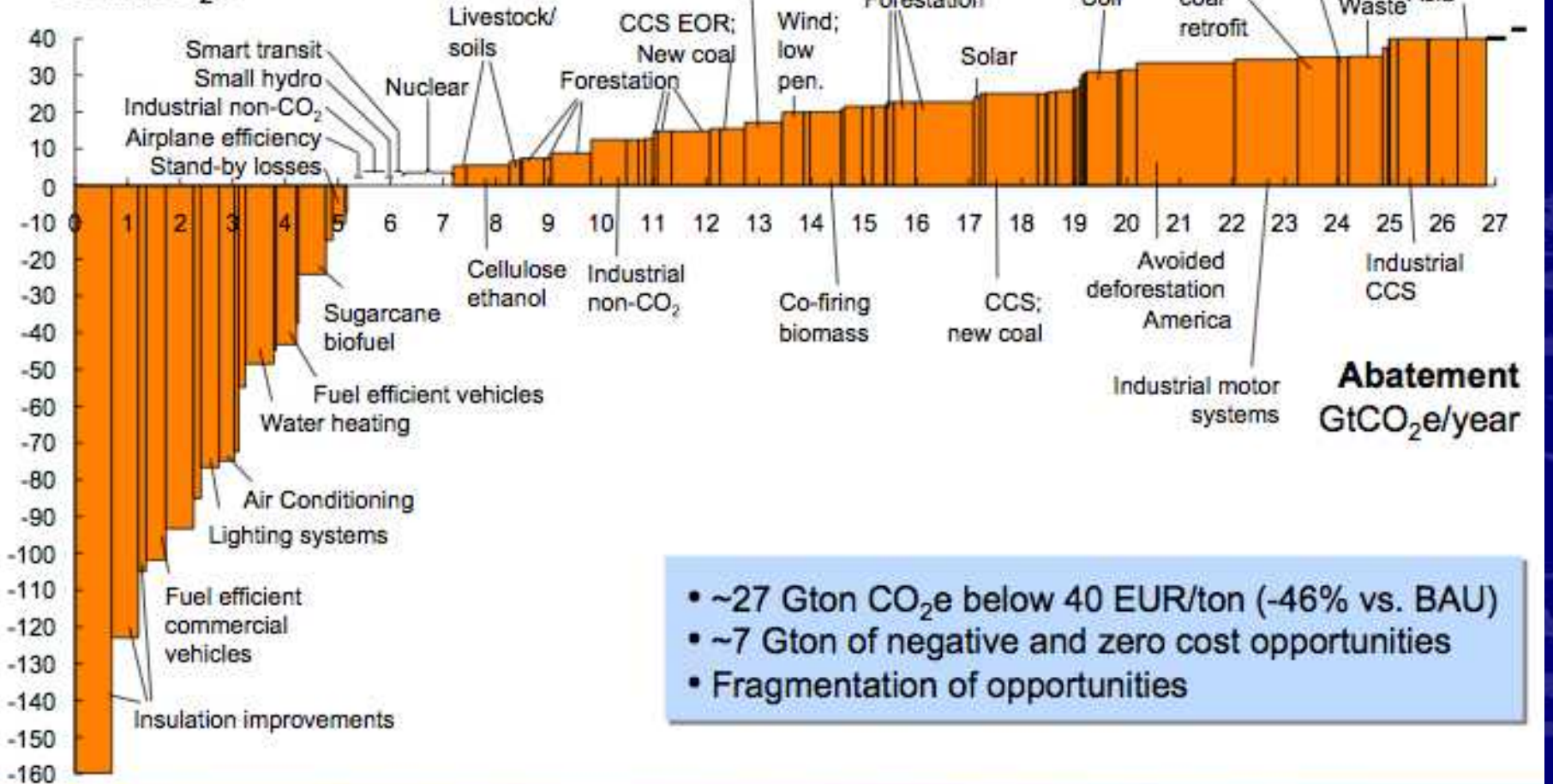


Jack-up barges cost 60M

# Global cost curve of GHG abatement opportunities beyond business as usual

2030

Cost of abatement  
EUR/tCO<sub>2</sub>e



- ~27 Gton CO<sub>2</sub>e below 40 EUR/ton (-46% vs. BAU)
- ~7 Gton of negative and zero cost opportunities
- Fragmentation of opportunities

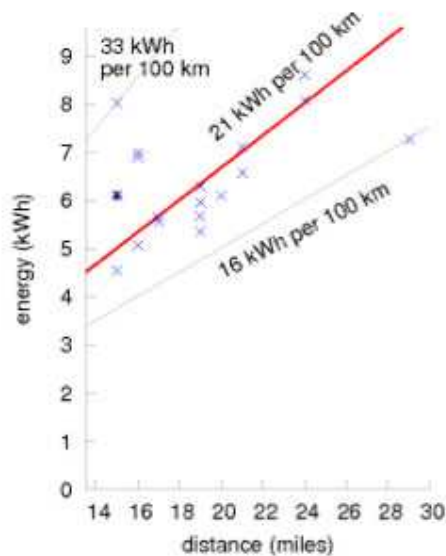
# Electric cars



● 21 kWh per 100 km (solo)

G-Wiz

● equivalent to 125 miles per gallon



data from Kele Baker



6 kWh per 100 km

# Energy crops and biofuels



Miscanthus

- Each year, Mankind uses fossil fuels derived from the fossil remains of plants and animals at a rate 400 times greater than the total annual growth of all plants and animals on Earth today.
- In production
  - food stocks (corn for ethanol, rape for biodiesel, sugarbeet or sugar cane for ethanol)
- Demonstration stage
  - miscanthus, willows and poplars grown on marginal land
  - algae derived biofuels
- Ethanol produced from corn in US has higher carbon footprint than derived from fossil fuels
  - biofuels or biofools?

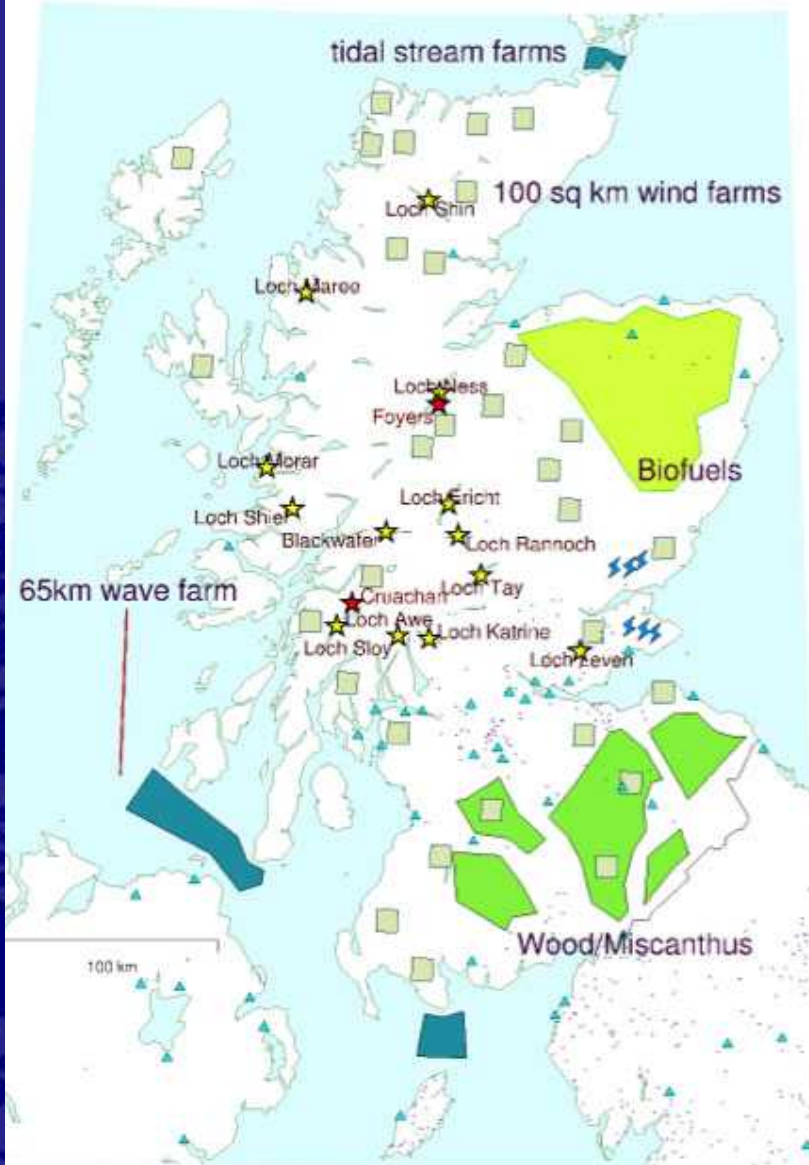
# Corn and Soya



- One sixth of the entire US corn harvest is distilled to biofuels to substitute for 3% of the nation's transport fuels.
- Even if the USA's entire corn and soya harvests were used to produce biofuels, they would satisfy only 12% of the USA's current thirst for petrol and 6% of its need for diesel.
- The situation in Europe is even worse : the UK, for example could not grow enough biofuels to run all the cars even if the whole country was put under the plough.

# Plan S: zero-carbon Scotland

No nuclear



Tide: 15+

Wave: 3

Hydro: 2

Waste: 1.1

Pumped heat: 12

Wood: 5

Solar HW: 1

Biofuels: 1

PV: 3

Wind: 28



Tidal stream



1,000 pelamis, 65km of coastline



all municipal waste incinerated, and equal agri. waste



Energy crops: 1200 sq m per person



4% of country  
30 windfarms, each 100 sq km  
- 6 times as much wind hardware as Denmark 



Pumped storage - 30 Cruachans  
Upgrade Anglo-Scottish interconnector



# Geo-engineering

## What are the options?

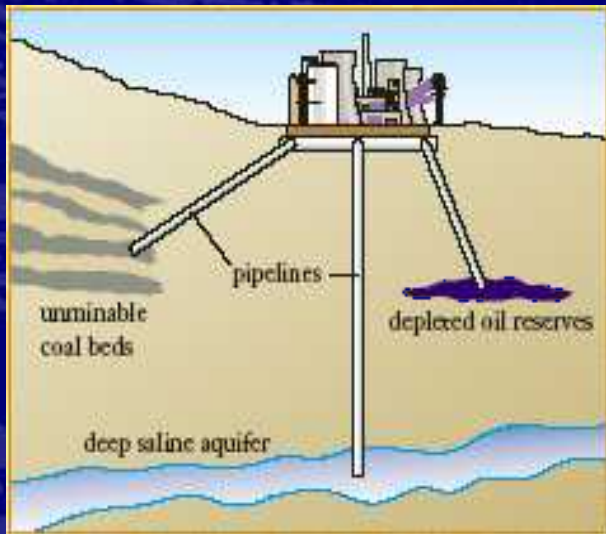
Synthetic trees

- Building a giant space mirror to reflect sunlight back to space
- Seeding clouds with salt particles
- Filling the Earth's higher atmosphere with sulphur
- Seeding oceans to encourage algae blooms to absorb CO<sub>2</sub>
- Deploying synthetic trees that pull CO<sub>2</sub> out of the air as air passes over them - but needing perhaps a quarter of all the world's power to run them

# CO<sub>2</sub> capture and storage



*Gas-fired power station*



- Capture in power production can be carried out by separating CO<sub>2</sub> from flue-gas
- Reduces power generation by 25%
- Captured CO<sub>2</sub> can be transported by high pressure pipelines or tankers to land-based or offshore geological sites
  - Fossil fuel power stations
  - Oil refineries
  - Petrochemical plants
  - Cement works
  - Iron and steel plants

*Enhance recovery from depleted oil reserves*

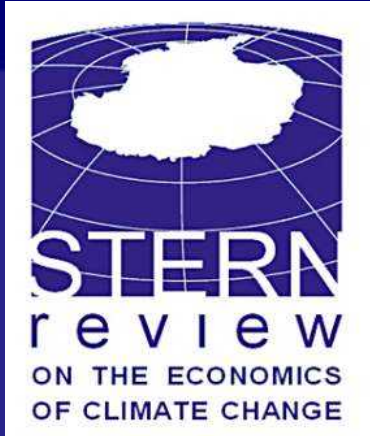
# Stern Review 2006

## Headline message for UK and world



Sir Nicholas Stern  
Former Chief  
Economist The  
World Bank

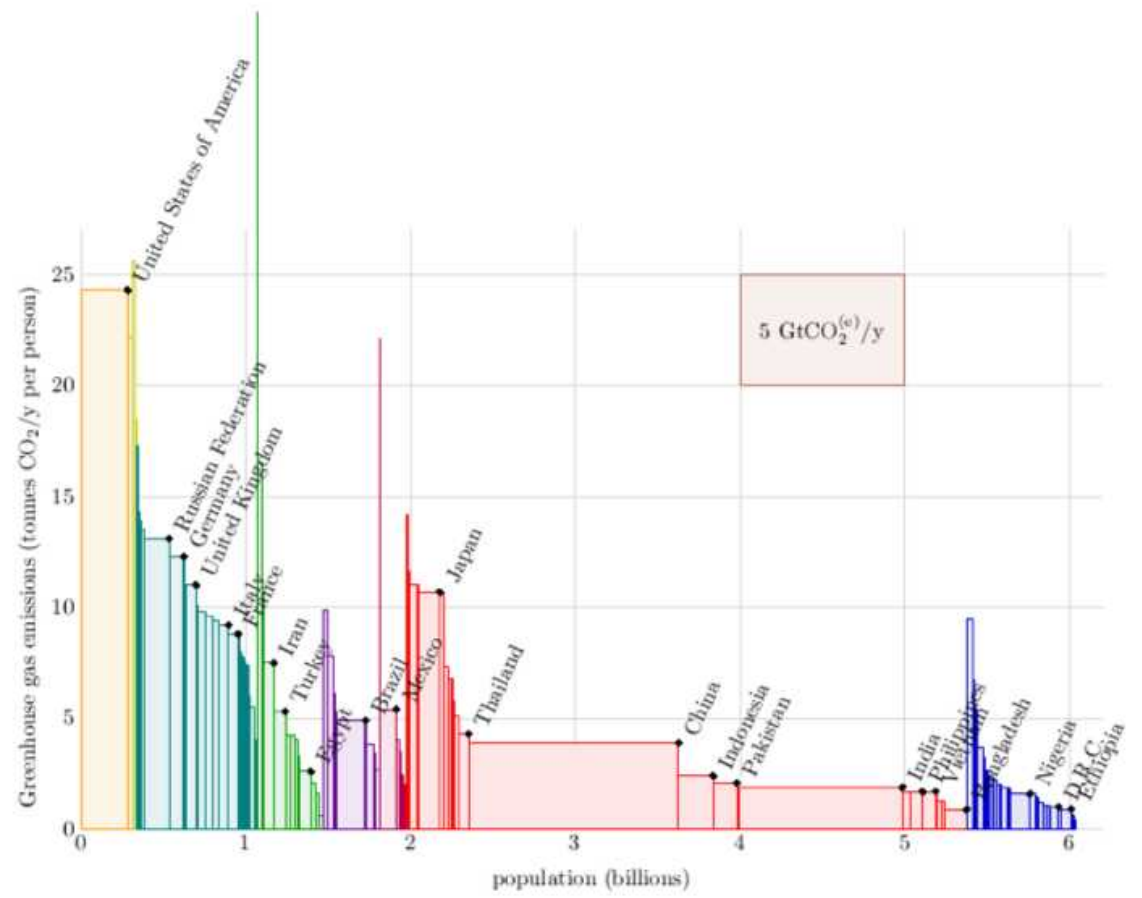
- Put aside 1% of our National Income to insure ourselves against a climate catastrophe that might wipe out 20% of our incomes
- 2009 Update
- *The damages I spoke of were underestimated; the emissions are increasing faster than we thought; the ability of the planet to absorb those emissions is less than we thought, and many of the effects are coming through faster than we thought*
- Need to put aside 2% of our National Income to put one on a safer trajectory to avoid dangerous climate change.
- Avoiding the worst of climate change is economic sense



The social cost of climate change  
The cost of adapting to the inevitable  
UK individual's share is £300 each year

- Economists argue over the benefits of combating the causes of climate change rather than adapting to later inevitable effects
- Adaptation measures include: improving flood defences, relocating cities and countries, strengthening buildings etc
- The social cost of carbon is the cost of adapting to the damage created by 1 tonne of CO<sub>2</sub>e
  - UK assessment: as low as £14 if the climate can be stabilized, and £40+ for a runaway future. US assessment around £15
- The shadow cost of carbon (UK) is a precise planning figure for energy infrastructure decisions to take account of future environmental damage
  - 2009 figure is £26 a tonne of CO<sub>2</sub>e

# Two worlds Rich and Poor Emissions per capita



Year 2000 data above  
Global average 5 tons/year/per person  
Europe twice world average  
N America 4x world average  
UK twice world average

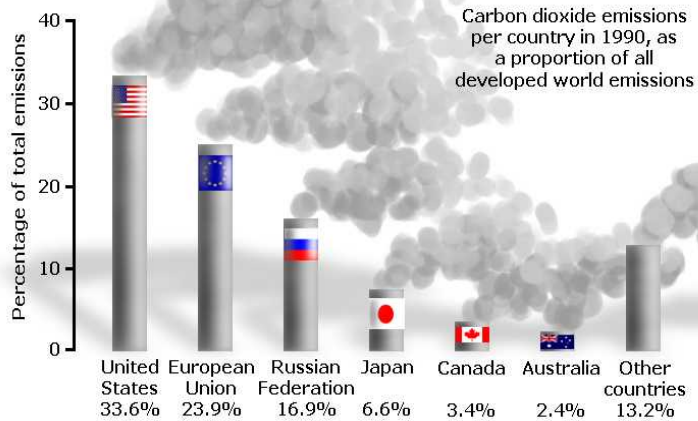




- The US accounts for 20% of the world's manmade greenhouse gas emissions. We also account for one quarter of the world's economic output.
- We recognize a responsibility to reduce our emissions.
- We also recognize the other part of the story, that the rest of the world emits 80% of all greenhouse gases, and many of those emissions come from developing countries.
- This is a challenge that requires a 100% effort, ours and the rest of the world's.

George W Bush

"Rose Garden" Policy Speech June 2001



The Kyoto Protocol became international law in February 2005 commitments end 2012

- Protocol required
  - Over 55 countries to ratify the Protocol.
  - Enough ratified countries for over 55 % of the emissions generated in the developed world (Annex 1) in 1990 to be covered
- Made no demands on developing countries (Annex 2)
- Demanded developed countries reduce their emissions to 5.2% below their 1990 emissions between 2008 and 2012
- Most developed countries will miss their emissions targets
  - 11 of 15 original EU nations will miss their targets
- Kyoto hardly slows climate change
  - at best reduces emissions **by 1% - 2%** below 'business as usual'
- Bleak prospects for agreement beyond 2012 with any clout



# Sir David King

UK Government Chief Scientist  
lecture at the White House

- Any alternative [to Kyoto] needs to accept that immediate action is required and needs to involve all countries in tackling what is a truly global problem.
- Developing countries would need to be brought into the process .... embedded in a framework that recognizes that issues of justice and equity lie at the heart of the climate change problem.



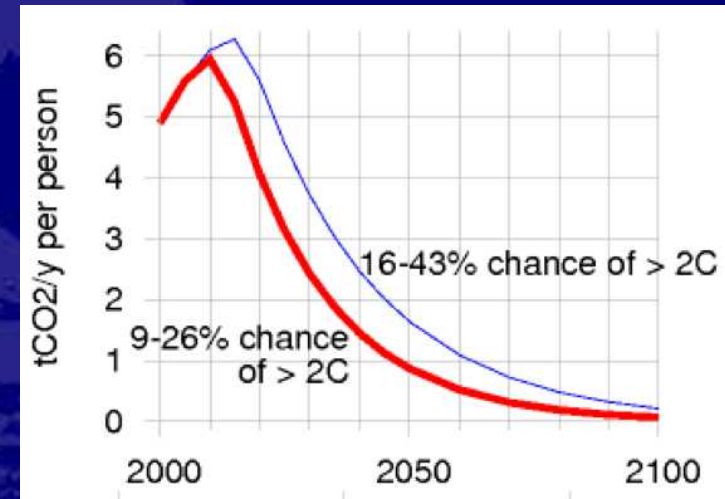


## CONTRACTION & CONVERGENCE

*The Global Solution  
to Climate Change*

Aubrey Meyer

# Converge and Contract for UK



- Towards a Fairer Society, endorsed by EU and UN
- Convergence: Equal emissions target per person by 2050
- Contraction: Falling global emissions for all beyond 2050
- For C&C, and 50:50 chance of reining climate change to less than 2°C, UK needs to get from its current 11 tons CO<sub>2</sub> per year per person to 1.5 ton per year per person in 2050
- This is close to the target of 80% cuts by 2050 in the UK Climate Change Bill



- What is now plain is that the emission of greenhouse gases, associated with industrialisation and strong economic growth from a world population that has increased six-fold in 200 years, is causing global warming at a rate that began as significant, has become alarming and is simply unsustainable in the long-term.
- And by long-term I do not mean centuries ahead. I mean within the lifetime of my children certainly; and possibly within my own.
- And by unsustainable, I do not mean a phenomenon causing problems of adjustment. I mean a challenge so far-reaching in its impact and irreversible in its destructive power, that it alters radically human existence.

Tony Blair

14 September 2004



- We will restore science to its rightful place and wield technology's wonders.....We will harness the sun and the winds and the soil to fuel our cars and run our factories.
- With old friends and former foes, we'll work tirelessly to lessen the nuclear threat and roll back the specter of a warming planet.
- And to those nations like ours that enjoy relative plenty, we say we can no longer afford indifference to the suffering outside our borders, nor can we consume the world's resources without regard to effect.
- For the world has changed, and we must change with it.

Inaugural Address, Washington  
January 20 2009

# THE AGE OF STUPID

FILM REVIEWS MAKING OF PEOPLE SCREENINGS STUFF NOT STUPID



Kingsnorth Coal Power Station is definitely Stupid



Taking trains instead of planes is Not Stupid

The Age of Stupid film hopes to focus world attention on the Conference of Parties to the UN Framework Convention on Climate Change in Copenhagen in December 2009



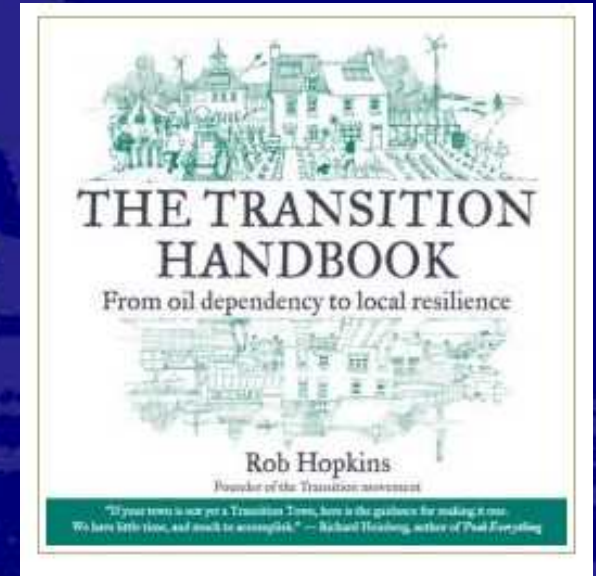
Wind turbines conversely are Not Stupid

# EU proposals for Copenhagen 2009



- Milestone after 2012 is 2020
- Developed countries should commit to cut their greenhouse gas emissions, as a group, to an average of 30% below 1990 levels by 2020
- Developing countries, as a group, should limit growth in their greenhouse gas emissions to 15-30% below business as usual levels by 2020
- Emissions from international aviation and shipping, which are not covered by the Kyoto Protocol, should have targets in the new agreement
- Financial and technological support should be provided to the most vulnerable developing countries
- Funding for energy-related research and development and demonstration projects should be at least doubled by 2012 and quadrupled by 2020

# Take home messages



- Climate change is real
- It is not going to go away and is caused by human activities
- The longer we leave things and the less we do, the worse the future will be and the more it will cost to put right
- Global emissions are accelerating
- There is no one clear technological solution
- Planning to live without fossil fuels is the ultimate challenge
- Each of us can make decisions for ourselves



## Final words

Lifestyle and behavioural changes will be very important and in very simple terms that means the use of walking, cycling, all of which will make human beings healthier and so also the planet.

Rajendra Pachauri

Chairman: Intergovernmental Panel on Climate Change

Our starting point is to help communities design a vision of where they see themselves in 20 or 30 years in a lower energy context.

Rob Hopkins

Founder: Transition Network